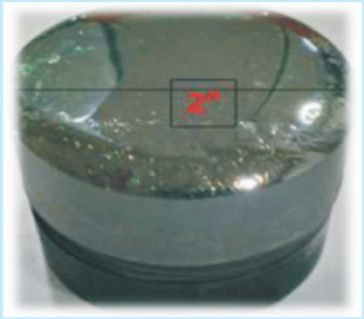
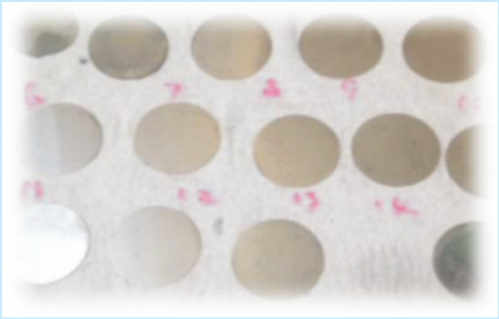
27th Year

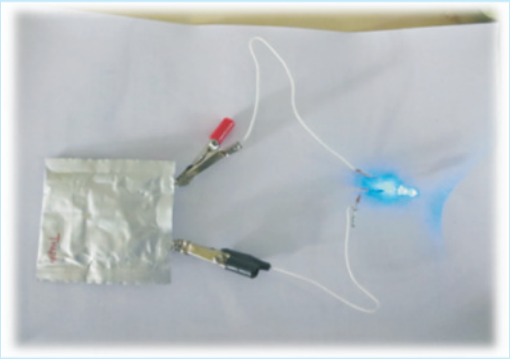
Wearable Electronic Device for Early Breast Cancer Detection

Annual Report
2016-2017





6H SiC Single Crystal Boule & Unpolished Cut Wafers



Nano-materials based Li-ion Battery Materials for EV Mobility

CENTRE FOR MATERIALS FOR ELECTRONICS TECHNOLOGY (C-MET)

Scientific Society under Ministry of Electronics and Information Technology (MeitY),
Government of India

Governing Council of C-MET (2016-2017)

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ANNUAL REPORT
2016 - 2017

CENTRE FOR MATERIALS FOR ELECTRONICS TECHNOLOGY (C-MET)

Scientific Society under
Ministry of Electronics and Information Technology (MeitY),
Government of India

VISION & MISSION

VISION

C-MET will become a premier R&D organization known all over the world for its knowledge base, innovations and expertise in Electronic Materials.

MISSION

To develop knowledge base in electronic materials and their processing technology for Indian industries and to become a source of critical electronic materials, know-how and technical services for the industry and other sectors of economy.

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PREFACE

It is my pleasure to bring out the Annual Report of C-MET for the year 2016-17. This report furnishes consolidated information on the activities, accomplishments, output and overall impact of C-MET during the period.

C-MET is a unique R & D institution rendering stupendous service to the nation in the niche area of electronic materials for over 26 years. As envisaged by peers, Honorable Governing Council and Steering Committee members, C-MET continues to excel in its commitment to R&D for strategic, commercial and social sectors and also successfully molding the young and vibrant researchers along the path of requirement driven R&D. The multi-disciplinary diverse R&D areas being engaged by C-MET demonstrates its commitment for delivering the products with quality, reproducibility and capacity buildup at pilot plant scale.

At this juncture, I would like to elucidate few notable achievements of C-MET in the financial year 2016-17.

During the year, C-MET has developed 7 technologies and efforts are ongoing to transfer them to Industries / Start-ups. This year, 6 sponsored projects were successfully completed and 10 new externally funded projects have been initiated. While, 21 sponsored projects are in progress, I am pleased to announce that C-MET generated EBR equivalent to the the funds supported by parental ministry by competing with other R&D agencies. I am delighted to acclaim the prodigious accomplishments by the committed and passionate personnel who each day toil to make C-MET's vision a reality.

This year also, we marched ahead with the practice of organizing a major scientific event in conjunction with the Annual Foundation Day (AFD) 2017. C-MET Annual Foundation Day 2017 was celebrated at Pune on 8th March 2017. On this auspicious occasion, an international conference entitled "Advanced Rechargeable Batteries & allied Materials (ICARBM-2017)" was successfully organized during March 8-10, 2017. There were 6 National and 15 international delegates from different parts of the globe including USA, UK, China, Japan, Singapore, South Korea and Australia who participated and delivered invited/plenary lectures and about 220 registered delegates attended the deliberations. Nearly 176 abstracts have been presented by students and R&D personnel from premier R&D institutions and industries in the field of advanced rechargeable batteries. The outcome would be useful in realising Prime Minister's vision (Mobility 2020) of making indigenous batteries for Electric vehicles (EVs) in the near future.

During the year, research performance indicators of C-MET continued to be impressive in terms of 52 research papers in peer - reviewed international journals, 53 contributory papers at various National/ International conferences, one technical report for DRDO and 43 invited talks at various National/ International scientific events. This year also, scientists and students from C-MET bagged several awards in the national conferences/symposia. All these awards and honors are testimony to the research excellence of C-MET research fraternity. During the year, C-MET achieved a further milestone by getting two US patents, on September 27, 2016 for High Dielectric Microwave Substrates (US patent no. 9,455,064) and on November 29, 2016 for Ultra Low Loss Microwave Substrates (US Patent No. 9505902), for the first time. I am sure that this will boost every scientist's confidence working even in the remote area of our country. Microwave Substrates have helped the nation in replacing

vacuum based klystron technology to most modern solid state power amplifier technology in linear accelerators at Department of Atomic Energy. Research at C-MET continues to touch greater milestones without sacrificing the focus on societal benefits. Our Scientists involved in early breast cancer detection, sensors for smart cities and extraction of precious metals like gold, silver, palladium from E-waste are some of the living examples.

I am happy to inform that extraction of precious metals from e-waste is in the advanced stage of completion with major process equipment designed and developed through indigenous components, which can save huge foreign exchange. Further, this indigenous technology will be handy in the Nation wide development of environmental friendly eco-parks. On the other hand, Silicon Carbide single crystals in known polytypes of 6H/4H can play a vital role in achieving high frequency and high temperature High Electron Mobility Transistor (HEMT) devices. Non-availability of these kind of devices has stalled many strategic programs of our country. The successful development of 6H and 4H SiC single crystals by C-MET is a proud moment for the nation, because it forms the basis for the indigenous fabrication of GaN electronic devices for Radar as well as 4G/5G communications.

On concluding note, I would like to bring Dr. B.N. Gupta's interaction with Sir Albert Einstein, wherein, Einstein explained how the meaning of 'Bhagavad Gita' acted as the main source of his inspiration and guidance for the purpose of his greatest ever scientific discoveries. C-MET's success is owing to re-orientation of confidence of young minds in to this deep path directly or indirectly, with perseverance.

We would like the Indian industries to embark upon our ideas to nurture the progress and progressive advanced technology findings in to the next era and augment the “Make in India” programme a grand success.

I earnestly anticipate that you will appreciate the achievements of C-MET and will find the reading material interesting, both in this report and on the website. Your suggestions and feedback are always welcome!

Dr. N. R. Munirathnam
Director General

Introduction

Centre for Materials for Electronics Technology (C-MET) has been set up as a Registered Scientific Society in March 1990 under Ministry of Electronics and Information Technology (MeitY), (formerly known as Department of Electronics) as a unique concept for development of viable technologies in the area of materials mainly for electronics. C-MET is operating with its three laboratories located at Pune, Hyderabad and Thrissur with specialized research mandate at each place.

Objectives

The objectives of C-MET are :

- To establish the technology up to pilot-plant scale for a range of electronic materials and transfer the same to industry for commercialization.
- To establish relevant characterization facilities.
- To undertake applied research activities in the area of its operation.

C-MET has set up its vision, mission and strategy to achieve its objectives.

R & D in Electronic Materials & Significance of C-MET

Electronic materials form an important segment of Advanced Materials. The materials technology is highly guarded by the major players considering their critical nature. Today, Information Technology (IT) is one of the premier global technologies. IT comprises data (or information) generation, categorization, transmission, retrieval, processing, and propagation to the benefit of society. Microelectronics is the keystone of information technology. A strong IT network needs supporting systems and sub-systems, which have the roots in the advanced electronic materials. Although electronic materials are primarily associated with computers, the internet and mobile technologies; they are used in many applications which help to improve overall quality of life and arrest climate change. Electronic materials form an extremely complex subject area. The progress made in traditional scientific fields often depends upon new developments in electronic materials. Advanced electronic materials (viz. nano-scale electronic materials for miniaturized subsystems and systems and nano-spintronics by considering, in particular, nano-architecture and scalability issues) have been identified as one of the critical technology areas by both developed and developing nations. Electronic materials are crucial to the total development of a nation irrespective of the preference be given to defence, agriculture, education, medicine, space or any other field. New heterostructure device concepts will be the basis for further improvements in micro and optoelectronics. High-K materials play an important role in down-scaling metal oxide semiconductor field effect transistors and dynamic random access memories. Non-volatile memories currently represent large proportion of the semiconductor market and are one of the most important technologies for mobile applications, the main end product being the flash memory. If the present trend is an indication, advancement in electronic materials technology may become the base of the total technology strength of a nation in future.

Research and development activities in the electronic materials domain have been pursued in various institutions in the country. **However, a clear focus to undertake client relevant R&D activities lies only with C-MET. This uniqueness of C-MET can be judged through its objectives laid down during its establishment.** All the developmental programs undertaken and carried out during previous years and currently are in accordance with these objectives. Various process and product technologies were developed in the area of electronic materials through all these years but a major stumbling block was the after effects of globalization and open market scenario immediately after the formation of C-MET. Understanding this scenario, new strategies have been evolved to increase the partnership of end users like industries and strategic sectors in C-MET's technical program.

Our Approach and Current Strategy

Our Approach

- Majority of Indian electronic materials related industries do not have well defined *in-house* R&D facilities and are not in a position to set up new production line for new technologies through scale-up. At the same

time, after the globalization, it has become imperative for them to improve their production with respect to quality, quantity and delivery time to compete with the foreign counterparts. To achieve this, they have to depend on either foreign collaborators or identify a suitable Indian partner, Who is capable of delivering the results. Industry had faced problems with absorption and up-gradation of imported technologies, to keep up with the latest trends in product quality and hence, it has become essential for them to improve with the help of agency like C-MET, which is having a strong knowledge base. C-MET has identified this as a right opportunity to shake hands with industry. A shift from the technology transfer to providing services to industry is required in the changed scenario.

- Strategic sectors have been routinely facing uphill task to procure the requisite materials or components for their operation from western countries. Indian industries are lacking in the cutting edge technologies. Identification of a right agency in both these cases is very important and C-MET has a major role to play in terms of bridging the gaps. C-MET's expertise, infrastructure and years long experience suit to take up this challenging responsibility. Hence, the total system has been mobilized and geared up to utilize the present situation in favour of C-MET. Accordingly, C-MET has signed major MoUs with DRDO, ISRO and DAE institutes.

Current Strategy

In order to accomplish the set objectives, we have adopted the following strategy for project execution at C-MET based on available expertise, competence and infrastructure to maximize the participation in strategic and industrial sectors.

- To develop the indigenous technologies in the area of Electronic materials to support the Industries for commercial application.

  To carry out these activities, C-MET has created basic infrastructure and facilities for development of Lithium ion batteries for automotive applications. Supercapacitors for hybrid batteries, EVM-VVPATs and LTCC compatible indigenous raw materials and packages for strategic sector.

- To implement projects which are expected to generate technologies/results which would be commercialized in the period of 5 to 10 years and the products/processes which are required for critical areas covering space, atomic energy, defense, etc, that are essentially small volume but high value products.

  C-MET has created Hafnium sponge production facility which can cater to the present demand to VSSC and BARC and tomorrow's electronic material demand. C-MET is the only place where this material is available in the country. Continuously supplying 'Flexible Microwave substrates' to RR CAT, Indore for Radio Frequency device applications. C-MET has also developed 2" SiC with 6H polytype single crystals for DRDO and presently engaged to extend the methodology for 4" and 6" crystal substrates for advanced GaN based communication devices applications.

- Electronic Waste, RoHS and Thermal sensor

  C-MET has also created NABL accredited RoHS testing and certification facility as per E-waste (Management) Rules 2016. C-MET has signed an MOU with CPCB for effective implementation of E-waste rules in the country. C-MET has developed knowledge base to extract precious metals like copper, silver, gold and platinum using environmental friendly processing of electronic waste at pilot plant scale.

  C-MET has developed thermal sensor based wearable early warning breast cancer detection device, which is user friendly, cost effective and precise compared to Mammography and allied diagnostics techniques.

- To develop strong knowledge base

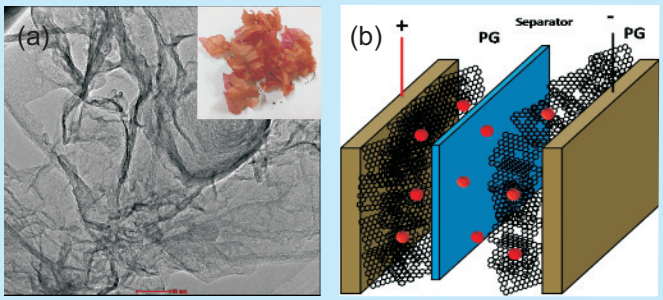
The technology development activities and pilot plant activities can not be sustained for longer period unless these are backed by internal scientific capability and expertise of required standard. This could be generated by various means, e.g. by undertaking basic research in the concerned areas within the country and/or abroad, undertaking training and research by C-MET scientists, as also, providing facilities in C-MET to outside agencies. This in turn will help in sustaining future activities of C-MET, as also, to achieve the objective of becoming the 'Centre of Excellence'. Moreover, development of strong knowledge base in specialized area of electronic materials is also essential from the standpoint of Knowledge Process Outsourcing as a global Phenomenon. Such activities are also necessary for providing motivation to young scientists.

C-MET is also working on Nanomaterials and Composites based sensors for Smart cities, Photocatalysts for clean and cheaper energy, Actuators and Teraherz materials for Homeland Security.

Core Competence at C-MET Laboratories

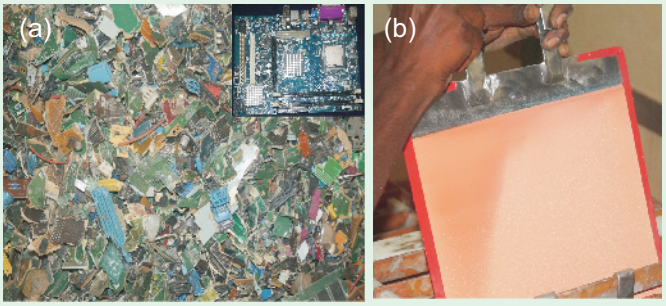
C-MET's R & D activities have been implemented in three laboratories at Pune, Hyderabad and Thrissur. The laboratory at Pune functions as headquarters also and extends central coordination support. Each of these laboratories has its own area of specialization with requisite infrastructure and expertise. This approach has proven to be successful in creating core competence at each laboratory.

- **Pune Laboratory**
  Materials for Electronic Packaging, Materials for Renewable Energy, Nano-materials / composites



(a) Unique perforated graphene derived from bougainville flowers and (b) schematic diagram of Supercapacitor with perforated graphene

- **Hyderabad Laboratory**
  Ultra High Pure (UHP) Materials, Compound Semiconductors, Refractory Metals, Alloys, RoHS and E-Waste



(a) Shredded PCBs and (b) deposition of pure copper on cathode by electrolysis of black copper extracted from E-waste

- **Thrissur Laboratory**
  Microwave Dielectrics, Super Capacitors, Multilayer Ceramics, Actuators and Sensors

(a)Aerogel and (b) aerogel based supercapacitors fabricated at C-MET

C-MET ORGANIZATION STRUCTURE

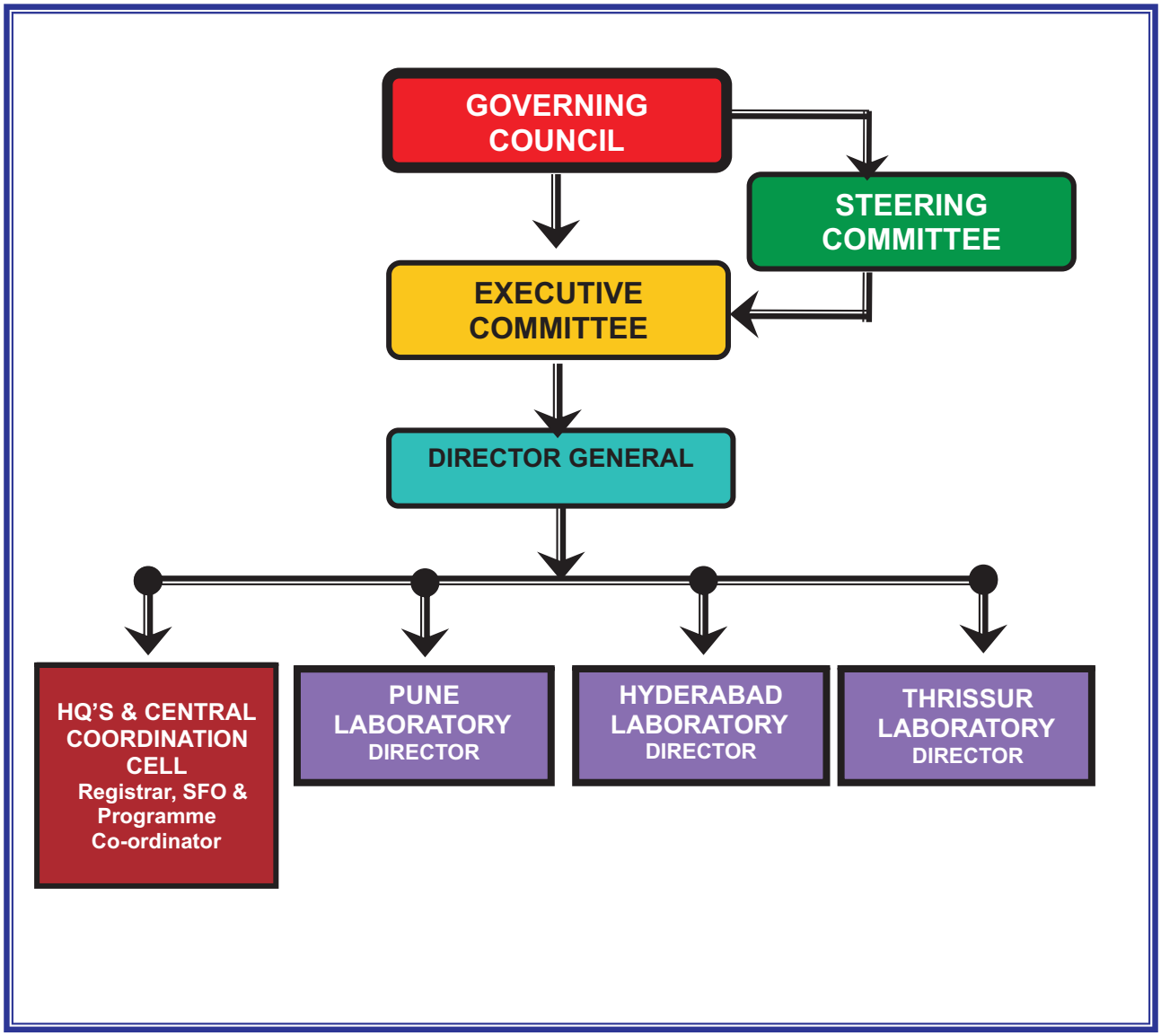


Figure 1 : Organization Chart of C-MET

Human Resource Indicators

C-MET team consists of 39 S&T officers, 34 S&T personnel and 35 administrative staff. Among S&T staff, 38 personnel are having Ph.D. degrees. Additionally, there are 139 Project staff/ Ph.D. students working at three laboratories of C-MET during the financial year.

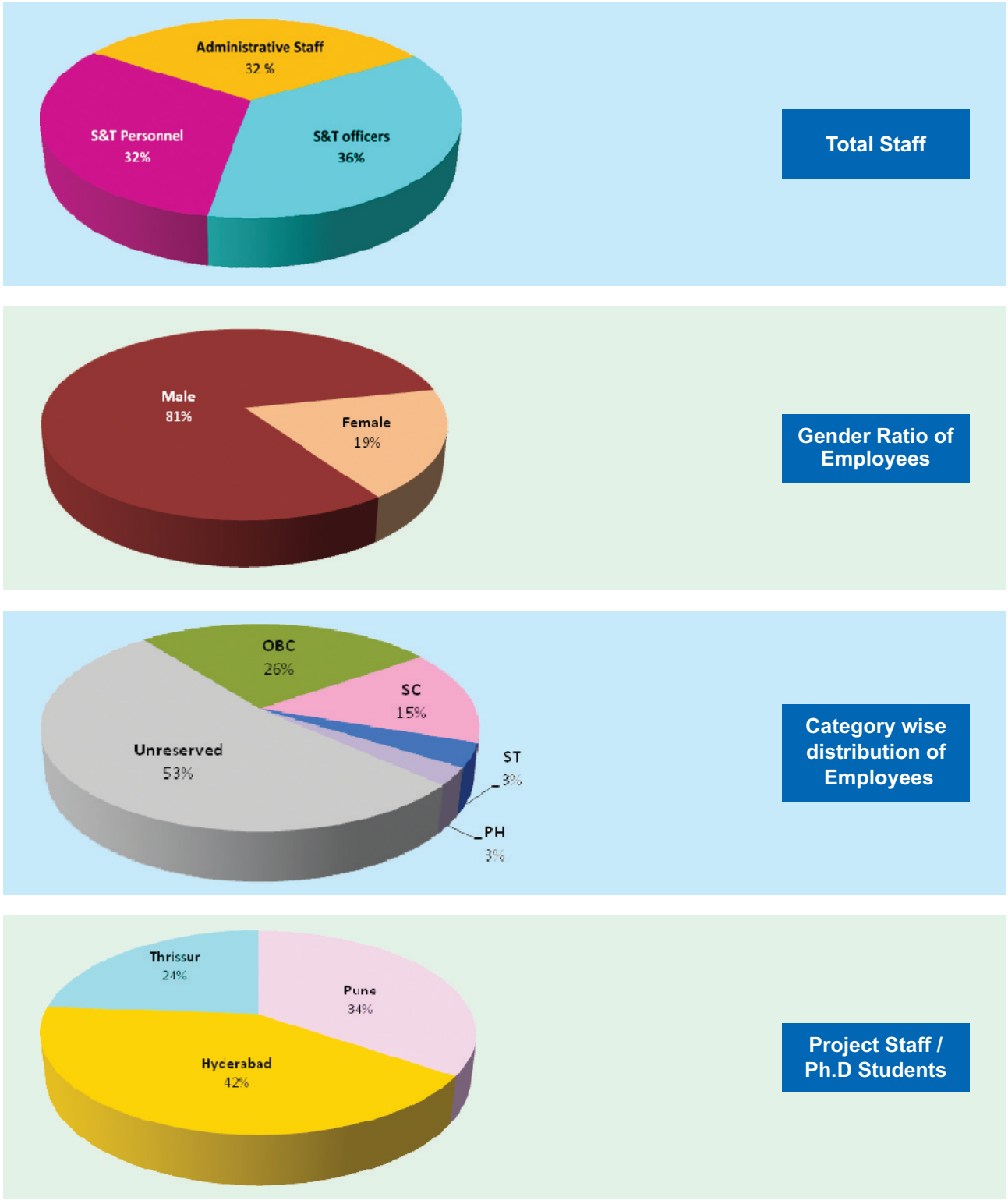


Figure 2 : Human Resource Indicators of C-MET

R & D Activities

During the year 2016-2017, the main technical activities of C-MET covered the following:

- Implementation of supplementary grant-in-aid projects from MeitY as well as various government & private funding agencies like DST, ISRO, BARC, BRNS, DRDO, DAE, Eaton Technologies, Medison Metals, etc.
- Technical services
- Materials characterization services

Core Program:

It was proposed to have a more coordinated and focused approach to the R & D area, where C-MET can deliver by exploiting its long experience in the development of traditional and advanced electronic materials and expertise gained hitherto and through inter-laboratory research interaction.

In this context, six major core programs as enlisted in the following table which have been selected for implementation.

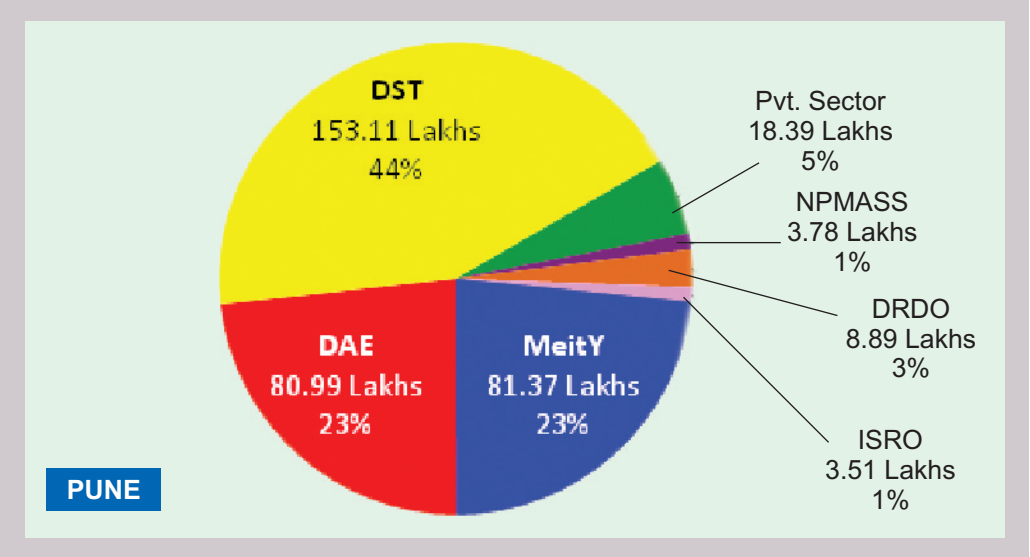
No.	Core Program	Selection Criteria	Broad Objectives
1	Integrated Electronics Packaging	• Strategic Requirement • Potential Hub for Electronics Packaging Solutions	• Development of LTCC Materials of integrated passive components. • Development of LTCC Devices. • Development of High Density Interconnects.
2	Nano-materials and Devices	• Advanced Research leading to Cutting-edge Technology • Potential for Knowledge Process Outsourcing	• Development of low loss transparent conducting oxide based plasmonic materials and devices. • Large scale synthesis of metal, metal oxide and metal nitride nanopowders by thermal plasma. • Development of nanomaterials for sensing applications for Smart cities. • Nanostructures for solar hydrogen production, solar cells, fuel cells and thermoelectric cells.
3	Ultra High Purity Materials & Compound Semiconductors	• Technology Transfer Possibilities • Probable pilot plant facility for UHP metals to meet limited demands of strategic sector	• Development of the technology and product upto pilot plant level and supply to meet the input materials requirements of strategic sectors, e.g. Space, DRDO and DAE. • Development of Process Technology for Refractory Metals Nanopowders. • Development of Process Technology for Silicon Carbide (SiC) Single Crystals.
4	Materials for Renewable Energy	• Energy Storage/Conversion Oriented Applications • Potential for Knowledge Process Outsourcing	• Development of process technology and supply of materials for solar energy and other renewal energy industries. • Development of semiconductor nanostructures for photocatalytic H_2 generation by water and H_2S

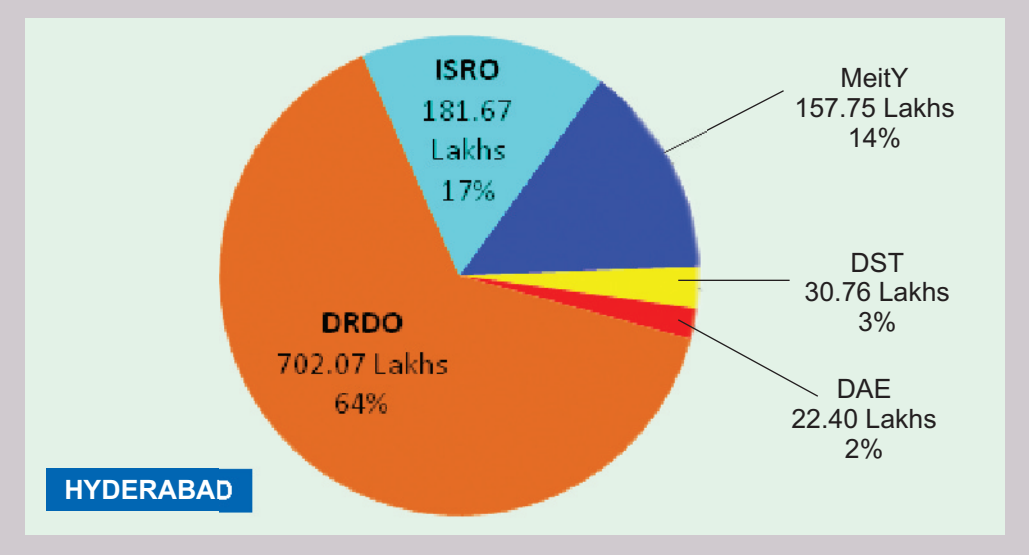
No.	Core Program	Selection Criteria	Broad Objectives
			splitting. • Development of nanoscale cathode, anode and allied materials for battery applications. • Thermoelectric materials and devices for energy conservation.
5	Piezo-sensors and Actuators	• For strategic and allied applications	• Development of Nano Material Based Thick Film Sensors. • Development of Nanoceramics for Microactuators & Varactors.
6	Electronic Waste and RoHS	• Recycling of Hazardous waste • Extraction of precious metals • Accreditation of E-waste through analysis and certification • Development of Standard Operating Procedure (SOP) for the analysis of Hazardas substances for	• E-waste : Development of pilot plant technology for environmentally safe recycling of E-waste and extraction and recovery of precious metals. • ROHS : Characterization of electronic and allied materials and products as per NABL requirements and certification of the products.

All these programs are supplemented / complimented by Grant-In-Aid sponsored projects.

Externally Funded Projects

In addition to ongoing sponsored projects continued from the last year, C-MET has initiated 10 new grant-in-aid projects and technical services projects, while, 6 projects have been completed during the year. C-MET earned an external funding (IEBR) to the tune of Rs. 1779.97 lakhs during the year 2016-17. The unit wise sponsored project funding pattern is depicted in Figure 3.





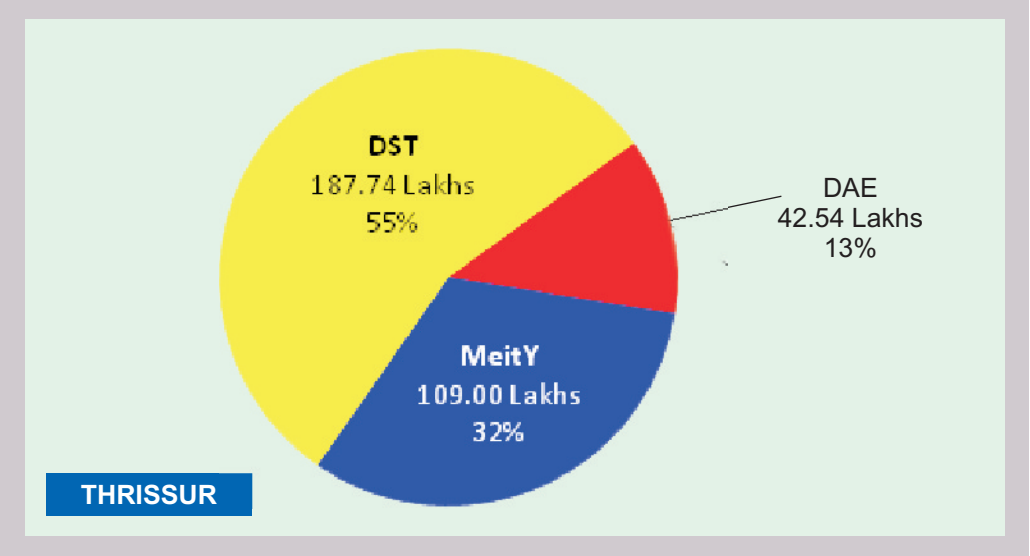


Figure 3 : Sponsored Projects at C-MET Pune, Hyderabad and Thrissur

The growth in IEBR is graphically shown in Figure 4

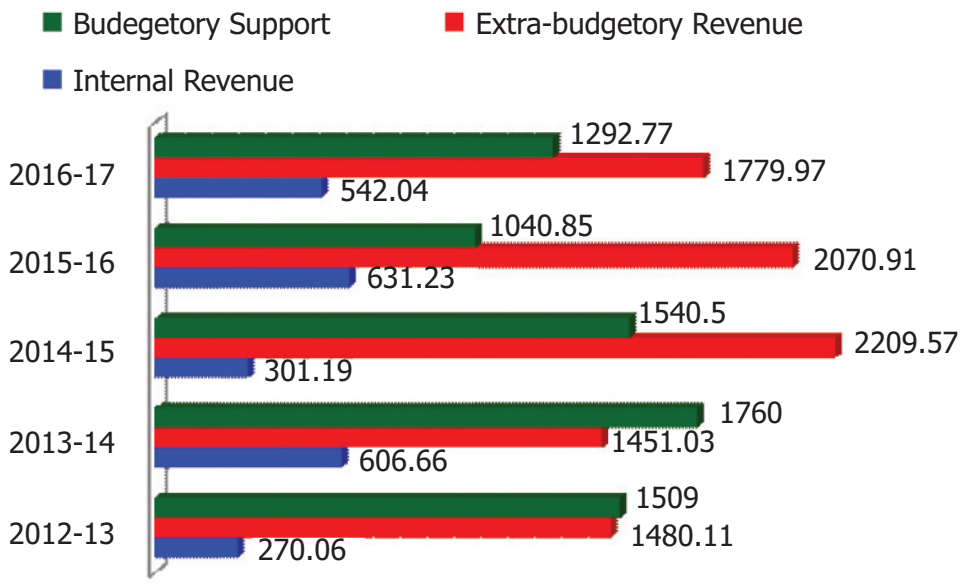


Figure 4: External Funding (IEBR) of C-MET since 2012-2013

C-MET has also been enhancing its intellectual outputs in terms of publications, conference papers, Indian and foreign patents and invited talks as seen in Figure 5. The trend clearly evidences better scientific recognition of the R&D capability of C-MET scientists.

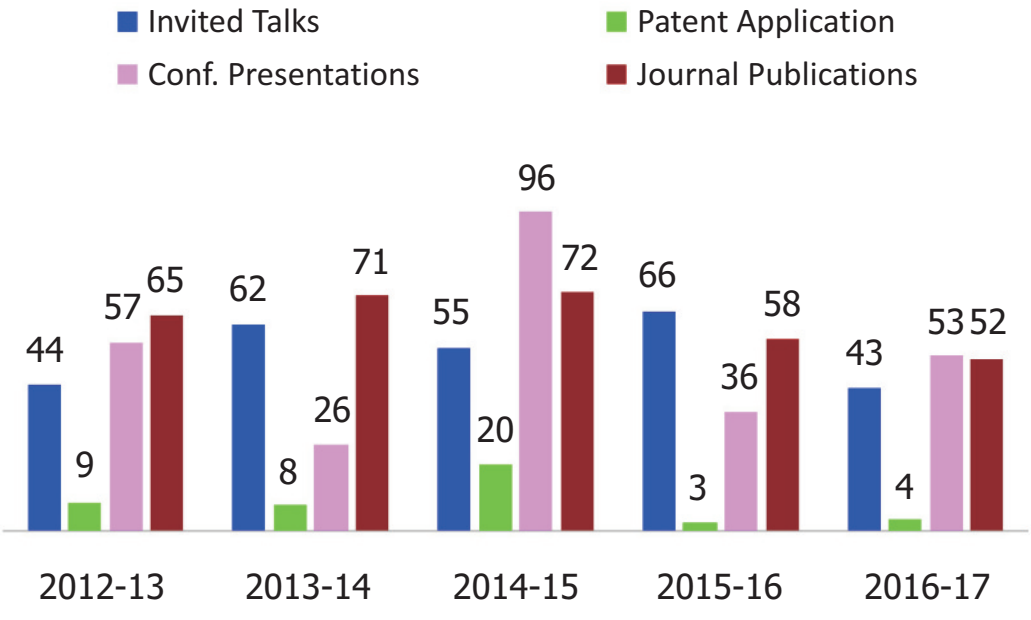
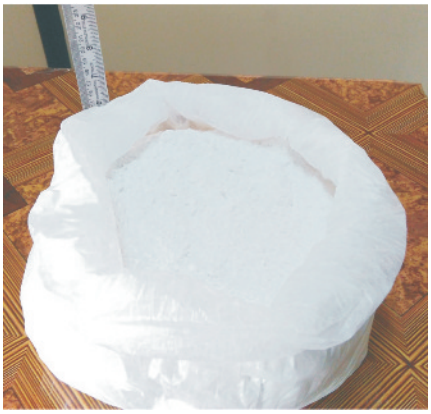


Figure 5: Intellectual Output of C-MET since 2012-2013

Technologies Ready for Transfer

This year 7 technologies are ready for transfer to Indian industries. The glimpses of these technologies are given below.

1. Modified silica filler for space applications



Modified silica is used as reinforcement filler in the adhesive used for bonding E-glass, strain isolation pads and ceramic tiles to space vehicles. C-MET has developed a technology for the production of space qualified and phase pure modified silica filler at pilot plant scale. ISRO used modified silica filler supplied by C-MET in their Space capsule recovery experiments. ISRO requires regular supply of modified silica filler for their Relaunchable Vehicle (RLV) applications. C-MET has so far supplied nearly 440 kg of modified silica filler to ISRO. Now, C-MET would like to identify suitable enterpreneurs for continuous production and supply to interested end user. Average particle size and density of modified crystalline silica are < 8 microns and 2.3 g/cc, respectively. The level of technology readiness at C-MET: 6.

2. Quickly Rechargeable Emergency Lamp

As a spin off technology of sponsored project on graphene based supercapacitors, C-MET has designed and developed an emergency lamp using supercapacitors. The salient features of the quickly rechargeable emergency lamp are, charging time (< 2 min), power dissipation continuously up to 0.5 to 1 hr and can be charged from renewable energy sources. Ideal for rural India, where there is no regular power supply and the lamp is very handy, light weight and can be sold at affordable price. C-MET has filed an Indian patent application (No. 265/DEL/2015) for this technology. The level of technology readiness at C-MET : 5.

3. Process for Nano-ZnO Powder


Pilot plant production facility for Nano ZnO

The pilot plant set up at C-MET Thrissur is capable to demonstrate the production of nano zinc oxide powders by spray calcinations with a batch capacity upto ~5 kg/day. The obtained powders have been tested as catalyst for deep desulphurisation applications. The ZnO nanopowder also possesses excellent application potential in consumer products, electronics, etc. The advantages of the pilot plant set up for the ZnO nanopowders are, average particle size of ~ 30 nm with a production capacity of 5 kg/day and enhanced catalyst performance with Nano ZnO. The level of technology readiness at C-MET : 6.

4. Microwave substrates with dielectric constant 6.15 and 3.0

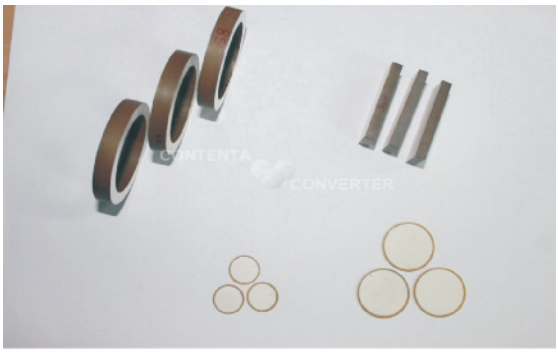
Low dielectric microwave substrates

C-MET has developed low dielectric and low loss ceramic filled polymer substrates suitable for microwave circuit design through a patented process. Copper cladding technology has been established to realize fine circuitry over the flexible substrates. These niche products exhibit excellent dimensional stability and tight dielectric tolerance suitable for high end microwave circuit design. Salient features of the indigenously developed substrates compared to commercially available ones are, ultra low loss tangent for selectivity, low dielectric anisotropy, tight dielectric tolerance and excellent temperature stability for outdoor wireless applications.

Dielectric constant of 6.15±0.15 and 3.0±0.03 at 10 GHz, loss tangent in the range of 0.0018 to 0.002 at X-band (~8 to 12 GHz), temperature coefficient of dielectric constant in the range of -18 to +25 ppm/°C, ultimate tensile strength >14 MPa and moisture absorption of 0.05-0.08% are typical properties of the microwave substrates. The level of technology readiness at C-MET: 6.

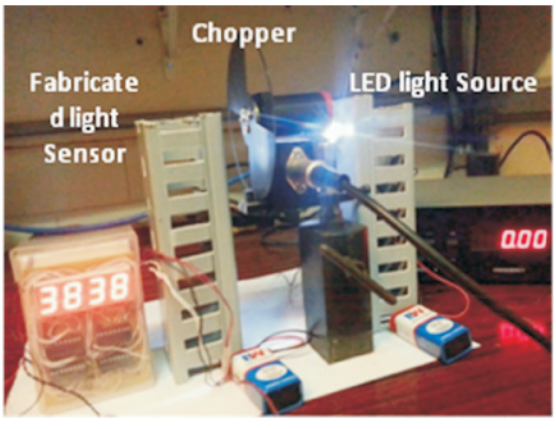
Band Pass Filters

5. Piezoceramic Compositions and Components



C-MET has developed piezoceramic compositions which are engineered for enhanced electromechanical properties. Different standard compositions are available. C-MET also has the capability for custom-made piezoceramic compositions to suit the requirement of a particular application. Piezoceramic compositions are typically suited for applications which include; piezoactuators, SONARS, hydrophones and other ultrasonic applications. The level of technology readiness at C-MET: 6.

6. Photopatternable Silver and Photoconductor Thick Film Pastes for Photo Sensors Application



Light detection is one of the kinds of sensor still catching the attention in various domestic and energy harvesting applications. This trend has created growing demand for miniaturization of conventional electro-optical system as well as for developing novel manufacturing technology to fabricate and integrate micro-optical system as a part of electronic device. In this regard, C-MET developed advanced thick film photoconducting materials and pastes, for light sensing application. Typical specification of the product are, fired thickness of 15-20µm, typical line width of 100 µm ±5%, visible spectral range, rise time ~ 2.5 - 60 ms, fall time up to ~ 65 ms and dynamic range of three order. The level of technology readiness at C-MET: 4.

7. Lead Free X-Ray Absorbing Materials & Medical Apron

Commercial lead based apron

C-MET developed nanomaterials based apron

There is always a slight risk of damage to cells or tissue from being exposed to any radiation, including the low levels of radiation. X-rays are harmful to the tissues under long time exposure. C-MET has developed lead free X-ray shielding material as well as fabricated medical apron using these materials. Salient features of the indigenously developed Lead free aprons compared to commercially available ones are Low cost, light weight, lead Free (Non-toxic) and hence Eco-friendly. Specifications of the product are nanostructured hexagonal BiBaS having average diameter of around 100 nm and the X-ray absorption /attenuation provide the protection level greater than 0.25 mm thick lead equivalence at 80 kVp. The level of technology readiness at C-MET: 4.

Core projects

The consolidated progress in respect of the core projects is furnished below:

No.	Title of the Project	Funding Agency	Total Outlay ₹ (Lakhs)	Achievements for 2016-2017
	C-MET, Pune			
1	To develop Carbon Nano Tubes (CNT) based composite lead-free solders for bumping applications	MeitY	62.00	• Metallization trials done with CNTs procured from local market. • Metallized CNT-lead-free solder co-depositon of composite using the imported as well as local market sources of MWCNTS. • Characterization of the composite in progress. • Bumping trials could not be initiated due to the non-availability of required funds for purchase of plasma asher.
2	WS_2-glass nanocomposite for gamma ray shielding	MeitY	60.00	• Optimization of the concentration of WS_2 in glass of 10 X 15 cm^2 dimensions. • Cut and polished as per dimension given by SAMEER. • X-ray and Gamma ray shielding measurements.
3	Synthesis of transition metal doped Hollow Glass Microspheres (HGM) for hydrogen storage applications	MeitY	53.00	• Prepared transition metal doped glass microspheres using sol-gel technique. • Installation and commissioning of spray dryer machine for HGM synthesis was completed. • Optimization of various parameters of spray drying technique for HGM synthesis was carried out. • Initial experiments for making HGM by oxypropane flame are underway. • Design and development of instrument for heating glass microspheres using oxy-acetylene flame are underway.
4	Development of aluminum (Al), alumina (Al_2O_3) and copper (Cu) mono-dispersed nanopowders by using Transferred Arc Thermal Plasma Reactor (TAPR) with plasma emission spectroscopy	MeitY	60.00	• Copper and copper oxide nanopowders were synthesized under different reaction conditions. • Feasibility study was performed to synthesize iron nanopowder by TAPR technique. • Process conditions were optimized for the synthesis of copper nanopowders at 250 g/ hr scale. • Optical Emission spectrograph is procured and installed. • Preliminary plasma emission studies were carried out for Ar laser and tungsten lamp.
	C-MET, Hyderabad			
5	Studies on the recovery of cobalt from spent Li ion batteries	MeitY	98.00	• Dismanteling and characterization of various types of spent Li ion batteries have been completed. • Sodium hydroxide leaching: Cathode material was leached with sodium hydroxide

No.	Title of the Project	Funding Agency	Total Outlay ₹ (Lakhs)	Achievements for 2016-2017
				for selective removal of aluminium. Nearly 98% aluminium was removed leaching with 5% sodium hydroxide solution. • Leaching of Co with Sulphuric acid and hydrogen peroxide. • A new Leaching method was developed with Citric acid which can dissolve Co, Li, Mn, Ni and can be selectively precipitated.
6	Establishment of Silicon Carbide (SiC) single crystals wafer process technology for electronic devices application	MeitY	638.65	• 2" diameter SiC single crystal grown at C-MET, Hyderabad was characterized at SSPL (DRDO) for its structural and physical chracteristics.
7	Process development for the extraction of rare earth oxides (yttrium, europium & terbium) from the spent fluorescent lamps	MeitY	54.72	• Estimated the content of rare earths in waste phosphors using ICP-OES. • Optimized the leaching experiments with 6N sulphuric acid @ 250 g batch scale. • Installed and commissioned Fluorescence Spectrometer for further investigations.
8	Design and fabrication of indigenous induction zone refiner for purification of "Germanium"	MeitY	160.00	• The pre and HEPA filters were replaced in the clean room. Germanium Metal received from SSPL has been analyzed to ascertain the initial purity.
	C-MET, Thrissur			
9	Development of NTC thermistors for radiosonde & meteorological Balloon application	MeitY	64.62	• Developed NTC chip thermistors which can be operated in the temperature range of -85°C to 50°C.
10	Magneto-dielectric substrates for miniaturised antenna application	MeitY	91.31	• Zn substituted analogue of W-type hexaferrite ($Ba(Zn_xCo_{1-x})_2Fe_{16}O_{27}$) for enhanced permeability have been prepared. • Solid state ceramic route through multiple calcinations was used to prepare phase pure CoW type hexaferrite ($BaCo_2Fe_{16}O_{27}$).

No.	Title of the Project	Funding Agency	Total Outlay ₹ (Lakhs)	Achievements for 2016-2017
				• Microwave Dielectric substrates that can be used for miniaturising RF circuits were prepared by dispersing the filler in PP and PEEK matrices.
11	Development of thin film waveguides for optical amplification applications	MeitY	167.00	• Highly transparent, uniform ferroelectric thin films based on $(Ba_{1-x}Sr_x)TiO_3$ have exhibited good contrast in refractive indices.
12	Development of transparent conducting oxide based plasmonic materials and devices	MeitY	109.24	• Real and imaginary parts of dielectric constant were extracted from spectroscopic ellipsometer and infrared reflectance spectra for the prepared transparent conducting oxide thin films.

Completed Grant-in-Aid Projects :

The major achievements in respect of completed *grant-in-aid* projects are furnished below :

No.	Title of the Project	Funding Agency	Total Outlay ₹ (Lakhs)	Achievements for 2016-2017
	C-MET, Pune			
1	Efficient waste water treatment using Novel Catalyst	INDO – UKIERI DST (08.05.14 to 31.03.17)	4.91	• The project has been completed on March 31, 2017. • Two scientists from C-MET, Pune visited UCL at UK during March 18 to 27, 2017. • Samples, i.e. nitrogen doped ZnO (optimized) have been prepared and used for water purification.
	C-MET, Hyderabad			
2	Establishment of extended pilot plat facility at C-MET Hyderabad for preparation of 320 kg hafnium sponge	VSSC (12.01.10) to 30.06.16)	2591.14	• Hafnium process technology demonstrated to Quality Control (QC) team of VSSC as per MoU. • The final QC report on the demonstration and Qualification Trials of Hafnium Sponge production was prepared and submitted to VSSC. • Nearly 15 kg of Hf sponge handed over to VSSC for Electron Beam (EB) refining. EB refined Hafnium was meeting the desired specifications. • Joint Project monitoring Committee declared successful completion of the project meeting all targeted milestones. • Project closure report submitted to VSSC. • The cost per Kg for continuous supply has been approved by VSSC for 320 kg Hf sponge/ annum @ Rs. 237,679 per Kg.
3	Development of ultra high purity germanium (Ge) for detector applications	BRNS (13.08.12 to 12.08.16)	23.90	• Developed high purity germanium required for detector applications.
	C-MET, Thrissur			
4	Development of titania aerogel photoanode for dye sensitized solar cell application	Nano-mission DST (30.12.12 to 30.06.16)	44.50	• Developed high surface area (150 m^2/g) nanocrystalline (10-20 nm) titania aerogel through supercritical drying technique. • Fabricated DSSC multilayer sturctured photoanodes using titania aerogel. • Titania aerogel based photoanodes showed higher dye loading capacity • Fabricated titania aerogel based DSSC test cell. • Aerogel based DSSC exhibited higher efficency than standard powder available from commercial market.

No.	Title of the Project	Funding Agency	Total Outlay ₹ (Lakhs)	Achievements for 2016-2017
5	Development of thin film solar cell with earth-abundant Kesterite absorber	DST (12.08.13 to 11.02.17)	45.83	• Developed phase pure kesterite (CZTS) thin film absorber films by solution routes meeting all the targeted specifications. • CdS buffer layer was coated by chemical bath deposition • Aluminium doped ZnO top layer was coated by radio frequency (RF) sputtering. • Developed kesterite based prototype thin film solar cell with device structure SLG/Mo/CZTS/CdS/AZO using manually coated Ag collection grid. The cell exhibited an efficiency of 7.8%.
6	Development of graphene supercapacitors for power electronics	MeitY (13.09.13 to 12.03.17)	80.11	• Developed graphene supercapacitors which meet the targeted specifications. • Graphene supercapacitor banks were made and tested. • ToT for quickly rechargeable emergency lamp was approved by GC held on December 19, 2016. • Initiated the process for inviting the Expression of Interest (EoI) from industries.

On-going Grant-in-Aid Projects:

The consolidated progress in respect of on-going *grant-in-aid* projects is furnished below:

No.	Title of the Project	Funding Agency	Total Outlay ₹ (Lakhs)	Achievements for 2016-2017
	C-MET, Pune			
1	Development of active materials (Cathode and Anode) for high energy density Lithium-ion cell/ Battery with fabrication of Prototype cell	MeitY (30.09.13 to 29.09.17)	498.05	• Installation and commissioning of battery fabrication facility was completed in Sept. 2016 and the facility is working satisfactorily. • Optimization of $LiCoO_2$ using spray dryer at 500 gm batch level completed. • Accumulation of active materials (cathode and anode) via repeated synthesis was carried out. • Trials were performed for fabrication of button/coin (15 Nos) and pouch /rectangular type (6 Nos) of cell using commercial materials as well as in-house developed materials using the newly installed battery fabrication facility. The cells /batteries were fabricated using different ratios of active materials: carbon black: binder. • Cyclic voltametry runs of fabricated button/coin type cells of different materials using electrochemical workstation have been carried out. • Testing of button / coin and pouch / rectangular type of cell of different materials with current rate (C/10 & C/20) using battery analyzer. • The first discharge capacities are 517, 493 $mAhg^{-1}$for Spherical hard carbon (PHC and BHC) samples, respectively, which is higher than that of the commercially used graphite anode (372 $mAhg^{-1}$). • For $Li_4Ti_5O_{12}$, coloumbic efficiencyiy remained constant at 100 % for C/10 and C/5. The specific capacity for $Li_4Ti_5O_{12}$ half cell for C/10 is 133 $mAhg^{-1}$. • The capacities during second charge and discharge stages were 102 and 96 $mAhg^{-1}$, respectively, for half cells of $LiCoO._2$
2	Prototype Development of Fuel Cell using nano functional materials	(MeitY with NIT Warangal (02.07.14 to 01.07.17)	31.68	• Synthesis and Characterization of RGO-Pt and Pt-Ni nanocomposites are completed. • Synthesis of Pt@conducting carbon completed and characterization is in progress. • Four samples were sent to NIT, Warangal for testing for fuel cell application. • As per requirement of the NIT, Warangal, synthesis of 5 gm of Pt-C and Pt/Ni-C catalyst is completed. • Analysis (HRTEM, XRD and UV-Vis spectroscopy) of the repeated batches is completed. • Fabrication of fuel cell prototype is in progress.

No.	Title of the Project	Funding Agency	Total Outlay ₹ (Lakhs)	Achievements for 2016-2017
3	Development of LTCC materials for general purpose applications	DST & C-MET (27.11.12 to 31.12.17)	441.57	• Developed and tested screen printable Ag and Ag-Pd pastes for thickness, warpage and for electrical properties. The properties are well comparable with the imported pastes. • Developed and tested via fill Ag and Ag-Pd pastes for thickness, warpage and for electrical properties. The properties of Ag based pastes are well comparable with the imported pastes. Ag- Pd pastes have to be modified. • Testing of LTCC tapes (4" and 6") received from C-MET, Thrissur were completed.
4	Fabrication of LTCC based induction coil magnetic sensor	BARC (19.01.15 to 18.01.17)	126.90	• The test results of the Mark-I sensor satisfied all parameters & were acceptable to user agency.
5	Development of visible Light Active Titanium oxynitride and Tantalum oxynitride Photo catalysts for H_2O Splitting	DRDO (12.05.14 to 11.05.17)	44.03	• Synthesis and characterization of N-doped Ta_2O_5 by hydrothermal treatment followed by calcination is completed. • H_2O splitting under visible light for H_2 generation using N-Ta_2O_5 has been completed. • Optimization of process parameters for the splitting of H_2O under natural sunlight is carried out.
6	Development of nanostructured PdTe powder for Thermoelectric application	BRNS (23.09.14 to 22.09.17)	19.00	• Phase pure PdTe samples were synthesized. • Seebeck coefficient measured at BARC, Mumbai at room temperature was in the range of -5 µvolt/Kelvin to 2.5 µvolt / Kelvin and shown metallic nature. • Two PbTe samples have shown very high resistivity of 2750 µohm*meter and 8000 µohm*meter at room temperature.
7	Development of Pressure sensors in LTCC	M/s Eaton Technologies Pvt. Ltd. Pune (04.05.15 to 03.07.17)	35.60	• The first set of submitted samples was tested and the results were acceptable. • The discussions on designs for next package were completed.
8	Synthesis and characterization of conducting polymer/ nanostructured WO_3 hybrid for low temperature NOx detection	ISRO (14.08.15 to 13.08.17)	14.41	• Synthesis of hierarchical WO_3 with different morphologies was carried out using variety of surfactants. • Sulfur doped WO_3 was synthesized by hydrothermal using thiourea and adipic acid as capping agent. • Experiments were carried out to make composite of WO_3 material with graphnene as well as with

No.	Title of the Project	Funding Agency	*Total Outlay* ₹ *(Lakhs)*	Achievements for 2016-2017
				polypyrrole and polyaniline. • WO_3 material was synthesized for the final sensor prototype. • Sensing studies were carried out for all the synthesized samples at different temperatures • Circuits were designed in simulation software to acquire the change in the resistance in the sensor and built it in real time.
9	Proof of the concept Development of Photopatternable Thick film thermistor Composite Materials for Temperature sensor Application	DRDO, Delhi (13.01.16 to 12.01.18)	64.62	• Synthesis of manganese ferrites for low temperature (around 500^{o}C) sensing by solid state method is optimized. • Preparation of electrodes on alumina substrates is completed. • Screen printing of sensing material on the prepared electrodes is completed. • Synthesis of yttria based compound by sol-gel method is carried out and characterization work is in progress. • Lab scale set up for low temperature sensing measurement has been built. • Resistance measurement for low temperature sensors is optimized for 40 samples and resistance is found to be varying in the range of MΩ to KΩ.
	C-MET, Hyderabad			
10	Sustainability and up-gradation of Government owned Restriction of Hazardous Substances (RoHS) test laboratory	MeitY (01.10.12 to 30.09.17)	524.93	• 550 Nos of RoHS, 1000 Nos of non-RoHS and 200 Nos of internal samples were analysed from various industries and from C-MET. • The 7th Industry awareness program on RoHS was conducted on May 06, 2016 at Park Hotel, Kolkata, where 55 Executive level participants have attended both from Industry and Pollution Control board of West Bengal. • The 8th Industry meet on RoHS awareness was conducted in collaboration with CII Pune chapter on January 25, 2017, where 55 delegates have participated. • NABL audit was conducted on April 23 & 24, 2017 and obtained the extension certificates valid until June 26, 2018. Project duration got extended by one more year up to September 2, 2017, with an extra grant of Rs. 57 lakhs and with extended objectives.

No.	Title of the Project	Funding Agency	Total Outlay ₹ (Lakhs)	Achievement for 2016-2017
11	Environmentally Sound Method for Recovery of metals from PCB's: Phase - II	MeitY (22.08.14 to 21.08.19)	1126.80	• 338.5 Kg of waste PCBs have been pyrolised and obtained 303 Kg of decomposed material. • 248 Kg of decomposed material was calcined by mixing with various fluxes in different ratios and smelted. 95.3 Kg of black copper was prepared and re-melted and casted to anode bars • The anode bars were electro-refined to extract 39.9 of Kg pure Copper and collected 3.4 Kg of anode mud from the polypropylene (PP) tank. • A new alkali fusion method was developed which can reduce 90-92% tin from anode mud. • Three new smelting gas fired furnaces with capacities of 5 Kg, 8 Kg and 15 Kg were designed and fabricated.
12	Development of system for preparation of high pure gallium nitride	DST (04.09.14 to 03.09.17)	67.88	• Homogenization and purification experiments on Ga were carried out following melting-solidification-re-melting scheme and were further purified to 5N+ purity level through directional solidification. • GaN samples were prepared by employing proto-type system, parameters were optimised and the samples prepared were characterized.
13	Development of Ultra purification process for high scale production of 7N grade Cd&Te.	SSPL, DRDO (08.12.15 to 07.05.18)	76.93	• Two batches of horizontal zone refining of Te and Cd were completed. • Samples from first batch were tested at NRC, Canada. Majority of impurity elements including crucial impurities such as Se and Zn were in acceptable limits and hence qualified for 7N grade for device fabrication. • Four Kg each of high pure Te and Cd supplied to SSPL, New Delhi as a part of project deliverables. • Studies were carried out to produce ultra pure Te and Cd on higher batch scale. Accordingly, new heaters were designed and tested for achieving narrow zone length. • Trial runs were carried out using higher dia quartz tube and boats to enhance through put.
	C-MET, Thrissur			
14	Development of Thermal Sensor Based Monitoring System for Early Detection and Screening of Breast Cancer	MeitY (27.03.14 to 26.09.17)	351.31 C-MET out lay: 139.85	• 12 numbers of wearable devices with different sizes were made. • Clinical trials of wearable device are going on at Malabar Cancer Centre (MMC). So far, 75 patients and 200 volunteers were tested in the clinical trials. Results were analyzed using C-MET developed software. • A theoretical model was developed by C-MET for constructing the image from the discrete temperature data obtained from the wearable device. • For classification of abnormality stages, a statistical analysis method was also developed. Hence a score can be given which indicates different stages of abnormality.

No.	Title of the Project	Funding Agency	Total Outlay ₹ (Lakhs)	Achievement for 2016-2017
15	Development & Setting-up of Pilot Scale Production of Aerogel Supercapacitors for electronic applications	MeitY & DST (01.08.14 to 31.07.17)	2210.66	• Designed, fabricated and commissioned the Pilot Plant at C-MET, Thrissur for production of organic aerogel at Pilot scale and the facility was inaugurated on May 20, 2016 by Padmabhushan Shri V.K. Aatre, former Scientific Advisor to Raksha Mantri, Govt.of India in the presence of officials from DST and MeitY. • Successfully demonstrated the production of aerogel in Pilot plant scale (8-10 kg/batch). • Also commissioned large volume carbonization furnace and produced Carbon aerogel in 3-5 kg/batch. • Prepared Aerogel Electrodes of different widths (upto 25 mm) and >100 m of aerogel electrodes were supplied to Keltron Component Complex Ltd. (KCCL, Kannur) for fabrication of Aerogel supercapacitors using automatic capacitor fabrication machineries. • Fabricated aerogel super capacitors of different size/values. They were tested using SCTS & EWS and optimized process parameters for making Aerogel super capacitors of 0.47 F, 1.0 F and 3.3 F.
16	Development of LTCC materials for general purpose applications	DST (27.11.12 to 31.12.17)	36.63	• Regularly supplied LTCC tapes of 4" x 4" and 7" x 7" inch to C-MET Pune.
17	Development of transition metal doped TiO_2 for photocatalytic generation of hydrogen by water splitting	BRNS (05.09.14 to 31.09.17)	23.90	• Photosensitive activity of the materials, TiO_2 and Fe, Co, Ni and Cu (0.001, 0.01 and 0.1M) doped TiO_2 were tested towards the H_2 generation by water splitting in an immersion type photoreactor. • For improving the H_2 amount, the reaction was carried out using various sacrificial reagents such as methanol, ethanol, IPA, glycerol, etc. along with water. The gas collected from the reactor outlet was analysed on a gas chromatography equipped with TCD (GC-TCD). • The reaction conditions were optimized by adjusting the reaction parameters such as amount of reagent, amount of catalyst, irradiation time, etc.
18	Development, production and supply of microwave substrates for 750 W amplifiers	BRNS (15.07.14 to 14.07.17)	214.00	• 150 nos. of Copper cladded microwave substrates having ε_r=3.5 and loss tangent, tan δ = 0.0018 were fabricated through SMECH process for high power solid state amplifier design. • High power solid state amplifiers were fabricated at the user agency, viz. RRCAT, Indore and system level evaluation was successfully carried out up to 1 KW. • Delivered 250 Numbers of Gold finished microwave printed circuit boards suitable for 750 W solid state amplifier to RRCAT, Indore on February 28, 2017.

No.	Title of the Project	Funding Agency	Total Outlay ₹ (Lakhs)	Achievement for 2016-2017
				• DAE IPR Division has accorded approval for filing Indian and US patent applications jointly by C-MET and RRCAT.
19	Aluminium internal electrode based Ultra Low Temperature Co-fired Ceramic (u-LTCC) for Microwave Electronic packaging application	BRNS (20.01.15 to 19.01.18)	24.55	• Alternate single phase Bi-Mo-O system that sinters at ~600 °C has been synthesized. Microwave characterization of sintered bulk ceramics for dielectric constant, Quality factor and Temperature co-efficient of resonance frequency was confirmed. Tape casting of the same is being carried out. • Dielectric properties were confirmed with the prepared Al paste which is comparable to that of Ag based paste.
20	Design & Development of Powerpacks with Aerogel supercapacitors & Fractional order modelling	BRNS (02.07.15 to 01.07.18)	190.61	• Developed new and cost effective technique in making aerogel carbons, suitable for supercapacitor electrodes. • Physical properties of aerogel carbons obtained by this alternate route were studied. • Optimised the process parameters for making aerogel in lab scale. • Carbon aerogels thus made were converted into corresponding aerogel electrodes and fabricated few aerogel supercapacitors for testing and evaluation of properties. • Aerogel Supercapacitors of cell capacitances 5F & 10F were given to IIT Bombay for testing at their end.
21	Textured PMN-PT based piezoceramics	DST-SERB (16.12.15 to 15.12.18)	26.13	• PMN-PT compositions of different ratios were prepared and confirmed the MPB composition. Evaluation of composition of PMN-PT and influence of seed particle phase is done. • Synthesized tabular ST7 through molten salt process. ST seed particles being prepared.

Newly Initiated Grant-In-Aid Projects During 2016-17

The consolidated progress in respect of newly initiated *grant-in-aid projects* is furnished below:

No.	Title of the Project	Funding Agency	Total Outlay ₹ (Lakhs)	Achievement for 2016-2017
	C-MET, Pune			
1	Development of microcrystalline silver powder for photovoltaic cells and EMI shielding applications	Modison Metals Ltd. Vapi (24.01.17 to 23.01.18)	26.44	• Prepared 5 gm silver powder using chemical route. • The same has been submitted to Modison Metals Ltd. for the analysis.
2	Development of electroplated binary and ternary Sn-Ag-Cu based lead free solder alloy for PCB application	DST (11.05.16 to 10.05.19)	68.17	• Technical specifications for spin coating system have been finalized. • Binary Sn-Ag and Sn-Cu bath formulations have been carried out. • Different chelating agents for development of a stable bath are being explored.
3	Fabrication of 2D heterostructures by CVD	BRNS (09.03.17 to 08.03.20)	34.99	• Technical specifications for dip coating system have been finalized. • Drafting of specifications for CVD reactor has been initiated.
	C-MET, Hyderabad			
4	Continuous Preparation of Hafnium Sponge	VSSC (29.08.16 to 30.11.16: (MoU-I) (16.02.17 to 30.04.17: MoU-II)	760.57	• MoU finalized between C-MET & VSSC for supply of 320 Kg of Hf Sponge / Annum. • Two MoUs signed for supply of 20 Kg of hafnium sponge in October 2016 and March 2017 respectively and closed after supply and receipt of money. • Supplied 10 Kg of hafnium sponge to VSSC against minimum monthly maintenance charges. • 235 Kg Hf oxide, 256 Kg Hf oxide briquette, 200 Kg Hf chloride and 57 Kg Hf sponge prepared.
5	SiC single crystal bulk growth process development: (Phase-II)	DRDO (01.08.16 to 31.07.20	998.78	• SiC phase-II project MoU signed between C-MET and DMRL on June 21, 2016 and first year budget of Rs 620.46 Lakh was received from DMRL (DRDO). • C-MET has entrusted BSNL, Hyderabad for civil augmentation of SiC lab with clean room facility. • Impurity analysis of SiC single crystal, SiC powder and graphite crucible was done using GDMS at M/s EAG, USA. • SiC project team attended numerical simulation training on PVT growth of SiC using Virtual Reactor software at DMRL during November 7-11, 2016.

No.	Title of the Project	Funding Agency	Total Outlay ₹ (Lakhs)	Achievement for 2016-2017
6	Ru(II) & Ir(III) - polypyridine dyads complexes with long-lived 3IL excited state as photosensitizers for visible light switches photocatalytic applications	DST (01.04.16 to 31.03.19)	37.00	• Synthesized three Ruthenium (II)-Polypyridine coumarin based complexes and were isolated and characterized. • They were utilized for the estimation of DNA photocleavage activities. • They were also studied for anti-cancer activities on Hela cancer cells.
7	Process Development for the recovery of rare earths from end of life compact fluorescent lamps (CFLs) and Fluorescent lamps	DST (02.09.16 to 01.09.19)	39.36	• 2 Batches of 6N H_2SO_4 leaching experiments were carried out on waste Phosphates. • Specifications were finalized and indented for process equipment.
8	Recycling of scrap Germanium to ultra high pure Germanium	DRDO (17.10.16 to 16.10.19)	122.07	• Specifications for refurbishment of clean room and Induction Zone Refining System were completed. • Germanium matrix volatization experiments have been carried out.
9	Development of ultra high pure Zinc for detector applications	BRNS (05.12.16 to 04.12.18	32.44	• Technical specifications prepared for Vacuum Distillation System for zinc purification.
	C-MET, Thrissur			
10	Magneto-dielectric (MD) substrates for miniaturized antenna application	MeitY (23.08.16 to 22.08.19)	140.82 (C-MET) 80.51)	• Prepared phase pure $Y_3Fe_5O_{12}$ MD filler. Prepared Y-type hexaferrite MD filler and its composite substrate samples for analysis

Major Pilot Plant and Infrastructure Facilities

I. Li-Ion Batteries: Facility for synthesis of Active Materials, Single Cell fabrication and Testing of Prototype Cells

C-MET, Pune has developed indigenous cathode and anode materials, established fabrication and testing facility for Coin/button (2032 type) and pouch/rectangular lithium ion cells. The capacity of the developed cells is found to be comparable with that of the commercially available cells.

Lithium ion cell fabrication and testing facility

Spray Pyrolyzer for cathode material preparation

Typical Coin and pouch cells using lithium based anode & cathode materials were fabricated at C-MET

II. Low Temperature Co-fired Ceramic (LTCC) Packaging

The Low Temperature Co-fired Ceramic (LTCC) facility has been established (over approximate 1500 sq ft built-up area with Class 10,000 standard) at C-MET, Pune. The laboratory is well equipped with the LTCC fabrication equipments for the fabrication of various LTCC packaging applications. The equipments include via punching, via filling, screen printing of conductive patterns on green tapes, stacking, lamination and co-firing. C-MET has also developed indigenous LTCC Tapes and pastes for general purpose LTCC applications.

Clean room of class 10000 and LTCC facility

III. Hafnium Sponge for Strategic Applications

C-MET, Hyderabad has established first indigenous Hf metal sponge plant to meet ISRO requirement. The input materials used is Scrub Raffinate from Nuclear Fuel Complex containing 1-2 % hafnium with respect to zirconium, which is further processed through solvent extraction to obtain HfO_2. Chlorination, Kroll reduction and vacuum distillation have been employed to get 99% pure Hafnium sponge. Hafnium sponge will also cater to the needs of Department of Atomic Energy in control rods of modern nuclear reactors. C-MET is also working on developing novel spin off products based on the indigenous availability of Hafnium in different forms.

Hafnium Plant

IV. Silicon Carbide Single Crystal Bulk Growth Facility

Silicon carbide (SiC) single crystal wafers is a promising material for high power, high temperature, high frequency device fabrication due to its wide bandgap, high thermal conductivity and high breakdown field. Ultrapure SiC single crystal is used for making blue LEDs, substrate for GaN devices, ultrafast high voltage Schottky diodes, MOSFETs, high temperature thyristors for high power switching devices, etc. In view of the strategic uses of SiC single crystals, an advanced sublimation reactor facility is established at C-MET, Hyderabad for 6H SiC single crystal growth of 2" diameter and 4H SiC single crystal boules, in collaboration with DMRL / SSPL (DRDO) to supply boules required for making substrates to be used in GaN technology at SSPL. Optimization of semi-insulating (SI) 6H SiC single crystal for device applications is under progress. Efforts are also being made to augment the SiC single crystal size to 6" dia and device grade wafers for SiC/GaN based electronic devices.

SiC sublimation Reactor

4H SiC Single Crystal boule

V. Recovery of Precious Metals from Electronic Waste

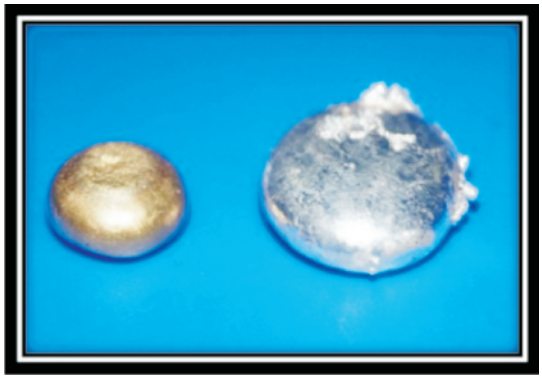
C-MET has established pilot plant facility for the Environmentally Sound method for the recovery of metals from printed circuit boards.

C-MET technology involves a combination of pyrometallurgy and hydrometallurgical operations wherein quantity of liquid effluents has been made minimal. Unique flux combination has been arrived at for effective separation of metal and slag. Prototype systems for the depopulation, shredding, pyrolysis, calcination, smelting and electro-refining are developed and successfully demonstrated up to 100 Kg per day. Full-fledged pilot plant scale facility is being established at industry partner M/s E- Parisaraa, Bangalore for a capacity of 1 ton printed circuit boards processing per day. Entire process is environmentally sound as the evolved gases are thermally processed for the complete destruction as per the CPCB norms.

Smelter

Pilot plant facility at E-Parisara

Electrolysis System



Recovered Gold and Silver

VI. Restriction of Hazardous Substances (RoHS) Test Facility :

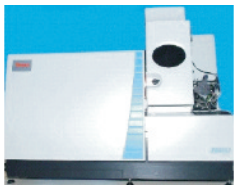
C-MET, Hyderabad laboratory has established a state of the art and NABL accredited chemical testing facility (bearing no. T-1780) for the analysis of electrical, electronic equipment and related Products to help the industries and developed a mechanism to identify and quantify the banned hazardous substances such as Pb, Cd, Hg, Cr^{6+}, polybrominated compounds, under E-waste (Management) Rules – 2016 in the area of polymers, metals, etc. This is the only Government owned testing facility in India established with the financial support of Ministry of Electronics & IT (MeitY), Government of India. In addition to NABL accreditation, C-MET is also having Bureau of Indian Standards (BIS), Govt. of India recognition for testing of mercury levels in Compact Fluorescent Lamps (CFLs) and Fluorescent Lamps (FLs) as per standard methods.

EDXRF (ARL Quant'X)

AAS with hydride generator

ICP-OES (725 Agilent)

ICP-MS (X S Ion)



Ion Chromatography

UV-Vis Spectrophotometer

GC-MS

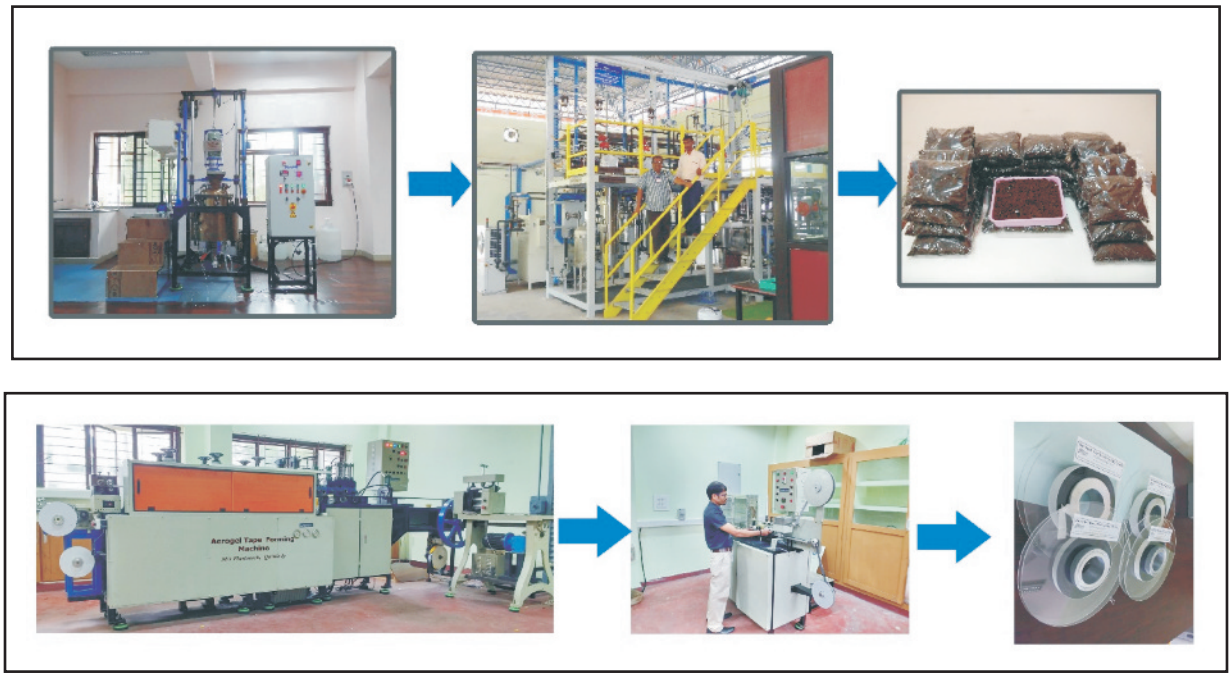
Microwave Digester

VII. Carbon Aerogel and Graphene based Supercapacitors

C-MET Thrissur has established the stat-of-art facilities for production of Carbon Aerogel and graphene and their conversion into supercapacitor electrodes and made prototype aerogel supercapacitor cells, which were tested by VSSC, Tata Motors, BARC, etc. and test results were found to be comparable to that of similar products of other manufacturers.

Facilities created :

- Large volume Gel reactor
- Aerogel production pilot plant
- Large volume atmosphere controlled Carbonization furnace
- Centrifugal milling machine for making Carbon aerogel powder (~100 µm)
- Automatic sieving machine
- Aerogel electrode forming machine including sub-unit for making electrode composition and fixing aerogel tape over metal foil (roll-to-roll)



Facility for Supercapacitor

VIII. Flexible Microwave Substrates for High Power Microwave and Medical Applications

Flexible microwave substrates are extensively used for variety of high end microwave circuit applications such as high power solid state amplifiers, patch antennas, missile guidance, mobile base stations, etc. C-MET, Thrissur has developed a patented SMECH process, which comprises of Sigma Mixing, Extrusion, Calendering followed by Hot Pressing for the fabrication of planar and dimensionally stable microwave substrates. Copper cladded microwave substrates with dielectric constant values 2.9 to 14.8 are developed indigenously for the first time.

Pilot Plant production facility for microwave materials processing

IMPORTANT EVENTS

RoHS Awareness Program: Seventh RoHS Industry Meet at Kolkata

7th RoHS industry meet entitled "Restriction of Hazardous Substances – RoHS Awareness, Compliance Testing & Certification under E-waste (Management) Rules – 2016" was conducted in collaboration with CII, Kolkata, on May 06, 2016 wherein 50 delegates participated from local Industries and Pollution Control Board.

Figure 6: Seventh RoHS Industry meet at Kolkata on May 06, 2016

Swachhta Pakhwada at C-MET Hyderabad

C-MET, Hyderabad observed Swachhta Pakhwada during November 1-15, 2016. All the staff members actively participated in cleaning the campus.

Figure 7: Swachhta Pakhawada at C-MET Hyderabad

RoHS Awareness Program: Eighth RoHS Industry Meet at Pune

8th RoHS industry meet entitled "Restriction of Hazardous Substances - RoHS Awareness, Compliance Testing & Certification under E-waste (Management) Rules - 2016" was conducted in collaboration with CII, Pune, on January 25, 2017 where 55 delegates have participated from industry.

Figure 8 : Eighth RoHS Industry Meet at Pune on January 25, 2017

National Science day celebration at C-MET, Pune during February 25-26, 2017

This year, C-MET, Pune celebrated National Science Day in association with C-DAC, Thyssenkrupp, Pune and Panachawati Utkarsha Seva Santha (PUSS). The National Science Day is celebrated all over India on 28th February in order to commemorate the invention of Raman Effect by Indian Physicist, Sir Chandrasekhara Venkata Raman on the same day in the year 1928. Main objective of this was to bring science in the forefront through celebration of the National Science Day (NSD), inculcate scientific temper and take pride in the scientific achievements of the country. The theme selected for this year science day celebration was, "Electronics In Our Life", as suggested by Prof. P. J. Lovakare. Under this theme, twelve exhibition stalls, each exhibit a separate sub-theme related to day-to-day use of, "Electronics in our life" were organised. Apart from this, science with fun, panel discussion on women in science and a lecture by Dr. Naresh Dadich were also arranged at C-MET and C-DAC premises. Almost, 25 number of C-MET, Pune research scholars have participated in the event. The Panchawati residents and other visitors appreciated the efforts taken by C-MET scholars, staff and Prof. Lavakare, for making Science Day Celebration a successful event. Separate brochure was published covering entire program for the science day celebration edited by Dr. Sudhir Arbuj.

Figure 9: NSD Celebration 2017 at C-MET Pune during February 25-26, 2017

National Science Day Celebration 2017 at C-MET Hyderabad

C-MET, Hyderabad laboratory celebrated National Science Day 2017 on February 28, 2017. More than 400 students from various schools and colleges visited the laboratory, interacted with the scientists and learned the basics of research & development

Figure 10: NSD Celebration 2017 at C-MET, Hyderabad on February 28, 2017

National Science Day Celebration at C-MET Thrissur

C-MET, Thrissur celebrated the National Science day on February 28, 2017. As part of the celebrations, the Center was open to the public and students from 9.00 am to 01.30 pm. People from various walks of life have visited the laboratory and have seen the exhibits of the products. Dr. Subha V, Chief Scientist (Sc G) Rtd, CSIR Technical and Business Consultant, Airport Instrumentation, National Aerospace Laboratories, Bangalore delivered the National Science Day lecture on 'Indigenous products development : challenges faced'.

Figure 11: NSD Celebration 2017 at C-MET Thrissur on February 28, 2017

Annual Foundation Day -2017 and International Conference on Advanced Rechargeable Batteries & Allied Materials (ICARBM-2017)

Centre for Materials for Electronics Technology (C-MET) Pune, celebrated its Silver Jubilee Annual Foundation Day on March 8, 2017. To commemorate the occasion, C-MET in association with Materials Research Society of India (MRSI), Pune Chapter organized an International Conference on "Advanced Rechargeable Batteries & Allied Materials (ICARBM)" at Sir C.V. Raman Auditorium, IISER-Pune during March 8 to 10, 2017.

Dr. B. B. Kale, Director, C-MET, Pune and Secretary, ICARBM-2017, welcomed all the delegates, personnel from industry, academy and research institutes. He also explained about theme of the conference and its significance. Dr. N. R. Munirathnam, Director General, C-MET and Chairman, ICARBM-2017 provided a Bird's Eye View on the Achievements of C-MET to the audience. He also presented a 'down-the memory-lane' pictorial presentation of C-MET over the last 25 years. Former Directors and Executive Directors of C-MET were honoured on this occasion. Additionally, those C-MET employees who have completed 25 years of service were also felicitated. Shri P. P. Chaudhary, Hon'ble Minister of State for Law & Justice and Electronics & Information Technology, New Delhi, delivered the Presidential address through pre-recorded video message. He applauded C-MET for completing 25 years and hoped that C-MET will be able to cater to the needs of industry and strategic sector with renewed vigour. Dr. Debashis Dutta, Group Coordinator, Ministry for Electronics & Information Technology (MeitY), New Delhi greeted C-MET, while giving Silver Jubilee wishes. He also explained some of the recent initiatives of the Government of India on Electronics policies like linking AADHAR to bank accounts and subsequently to various subsidy schemes. Padmabhushan Dr. Vijay Bhatkar, Chancellor, Nalanda University, Rajgir, graced the function as the Guest of Honour. He recollected the fond memories of the process of conceptualization and realization of C-MET. He stressed the need of the cross-border or trans-national research for not only the betterment of the country alone but also for the mankind. Padma Vibhushan Dr. R. A. Mashelkar, National Research Professor and President, Global Research Alliance, Pune, presided over the function as the Chief Guest. He expressed his admiration to C-MET for completing 25 glorious years and making rapid strides in the field of electronic materials research. He commended some of the C-MET initiatives which are beneficial for the society and some of which have industrial potential. Dr. Mashelkar recommended to Ministry representative, Dr. Debashis Dutta that the budget of C-MET should be enhanced by at least 10 times more than the existing one in order to take up the proposed plan of action in the most exciting R&D areas. He also adviced C-MET to take up the developed early breast cancer detection technology to the masses and keep the cost of testing around Rs. 50 per patient so that many rural population will avail this facility.

Prof. Orlando Auciello, Endowed Chair Professor from University of Texas-Dallas delivered the foundation day seminar. Dr. Ashok Joshi, former President, CERAMTEK, USA, delivered the Public Lecture on Innovations and Abundance. About 23 eminent Scientists from USA, UK, Japan, Spain, South Korea, China, Singapore and nearly 250 Scientists from industry and academy participated in the deliberations for three days.

Figure 12: Inaugural Function of Annual Foundation Day-2017 and International Conference on Advanced Rechargeable Batteries & Allied Materials (ICARBM-2017)

Shortlisting of Early Breast Cancer Detection project under PM's Innovation Award

Ministry of Personnel, Public Grievances & Pensions, Department of Administrative Reforms & Public Grievances, Govt. of India has called the proposals for "PRIME MINISTER'S AWARDS FOR EXCELLENCE IN PUBLIC ADMINISTRATION". C-MET's innovation on **"Development of Thermal Sensor based Wearable Device for the Early Detection and Screening of Breast Cancer"** has been shortlisted as one of the 10 best innovations considered for the Prime Minister's Award for Excellence in Public Administration (Innovations Category). Out of 830+ innovations received, 10 innovations have been shortlisted as best practices. The honour is recognized on India's Civil Services Day, i.e., on April 21, 2017. The news article mentioning short listed innovations for PM's Awards is given below.

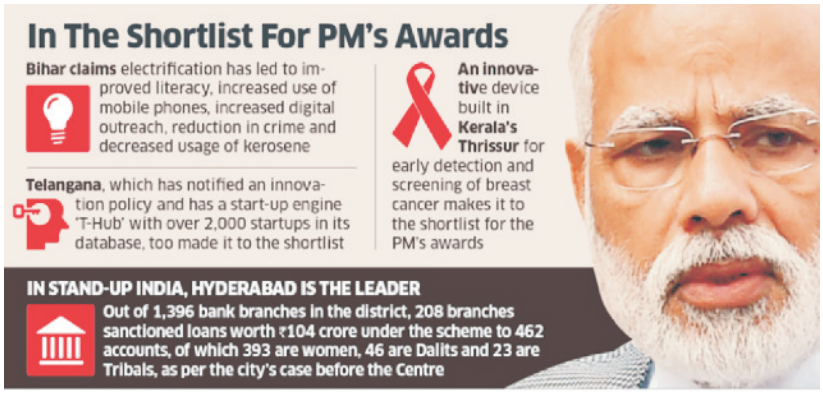


Figure 13: C-MET in the shortlist for PM's award.
Photo Courtesy: The Economic Times, March 29, 2017.

Figure 14: C-MET Personnel introducing the wearable device to a group of rural woman

Figure 15: Clinical trials of wearable device undergoing at Malabar Cancer Centre

Delivery for first phase High Power Solid State Amplifier Printed Circuit Boards to RRCAT, Indore

As a part of first phase deliverables of the MoU project, 250 Numbers of Gold Finished microwave printed circuit boards suitable for 750 W solid state amplifiers were delivered to the Director, RRCAT, Indore on National Science Day, February 28, 2017.

Figure 16: Delivery of first phase Microwave substartes to RRCAT, Indore

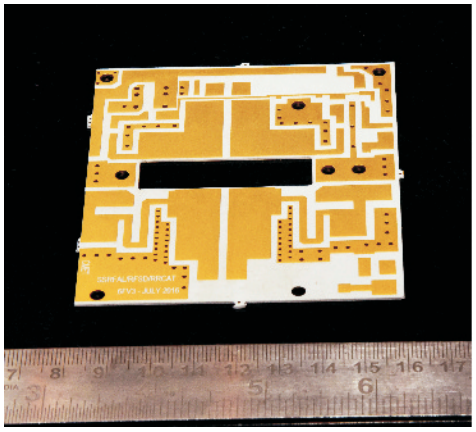


Figure 17: High Power Solid State Amplifier (SSA) PCB Design – Front View

Figure 18: Gold finished Circuit Boards for SSAs Delivered to RRCAT, Indore

Memorandum of Understandings (MoUs)

Signing of MoU between C-MET and DMRL

A MoU was signed between Defence Metallurgical Research Laboratory (DMRL), Hyderabad, and Centre for Materials for Electronics Technology (C-MET), Hyderabad, by Dr. Samir Kamat, Outstanding Scientist and Director, DMRL and Dr. N. R. Munirathnam, DG, C-MET on June 21, 2016. The purpose of the MoU is to lay down the general framework of collaboration between C-MET and DMRL to work on the development of SiC single crystal bulk growth using DRDO funded Physical Vapour Transport (PVT) reactor facility at C-MET, growth and supply of 30 numbers of SiC single crystal boules with desired target properties, and any other related work mutually agreed upon.

Figure 19: Signing of MoU between C-MET and DMRL on June 21, 2016.

Signing of MoU between C-MET and VSSC

MoU was signed between Vikram Sarabhai Space Centre (VSSC) and Centre for Materials for Electronics Technology (C-MET) on August 29th, 2016 for the development and supply of Hafnium sponge.

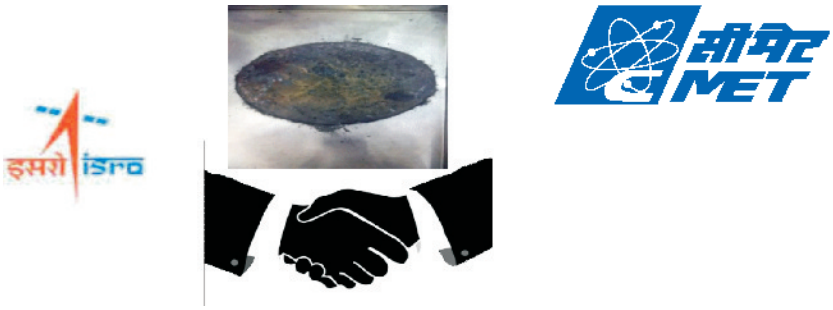


Figure 20: Signing of MoU between C-MET and VSSC on August 29, 2016.

C-MET Signs MOU with CPCB under MOEF & CC for the analysis of hazardous substances to implement E-waste (Management) Rules 2016.

MoU was signed between Central Pollution Control Boards (CPCB) and Centre for Materials for Electronics Technology (C-MET) on February 13, 2017 for the evaluation of hazardous substances in the imported and exported electrical and electronic goods, collected by CPCB on random checking basis, from manufacturers/dealers/retailers, etc., for checking the compliance of E-waste (Management) Rules 2016 in the country. Accordingly, CPCB guarantee C-MET atleast 100 products with a minimum of 15 homogenous samples amounting to 1500 homogenous samples per annum.

Figure 21: Signing of MoU between C-MET and CPCB on February 13, 2017.

Distinguished Visitors:

1 Shri. Ravi Shankar Prasad, Hon'ble Minister for Law & Justice and Electronics and Information Technology, Government of India visited C-MET Pune on September 3, 2016. Shri Anil Shirole, Hon'ble Member of Parliament, Lok Sabha and Prof. Rajat Moona, Director General C-DAC, also accompanied Hon'ble Minister during the visit.

Figure 22: Shri. Ravi Shankar Prasad, Hon'ble Minister for Law & Justice and Electronics and Information Technology, Government of India at C-MET Pune with dignitaries and C-MET staff

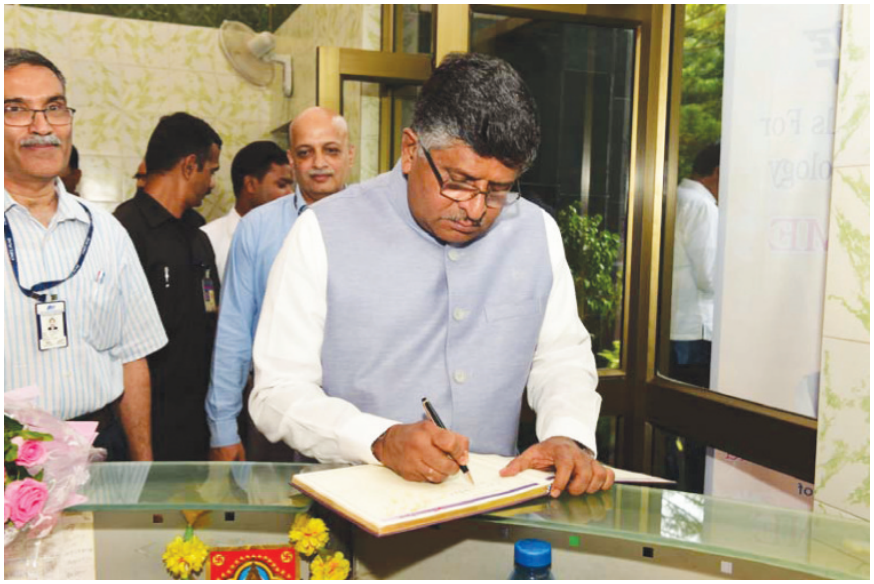


Figure 23: Shri. Ravi Shankar Prasad, Hon'ble Minister for Law & Justice and Electronics and Information Technology, Government of India is penning his impressions on C-MET R&D work in the Visitors book after completing his maiden visit

2. Shri. P.P. Chaudhary, Hon'ble Minister of State for Law & Justice and Electronics and Information Technology, Government of India visited C-MET Pune for the Review Meeting on November 20, 2016.

Figure 24 : Shri. P. P. Chaudhary, Hon'ble Minister of State for Law & Justice and Electronics and Information Technology, Government of India planting a tree at C-MET, Pune

Figure 25: Shri. P. P. Chaudhary, Hon'ble Minister of State for Law & Justice and Electronics and Information Technology, Government of India observing the features of Spray Dryer system at C-MET, Pune

3. Dr. U. Hareesh, Principal Scientist, National Institute of Interdisciplinary Science and Technology (NIIST), CSIR, Thiruvananthapuram visited C-MET, Hyderabad on December 15, 2016 and delivered a lecture on "Non wetting inorganic surfaces based on rare earth phosphate for metallurgical applications".

4. Dr. Nivas Babu, Department of Materials and Ceramic Engineering/CICECO, University of Aveiro, Portugal visited C-MET, Hyderabad on March 02, 2017 and delivered a lecture on "Materials for Hydrogen Storage".

5. Dr. S.A. Ilangovan, visited C-MET, Thrissur Group Director Chemical Systems Group, PCM Entity Vikram Sarabhai Space Centre (VSSC), Trivandrum on August 18, 2016.

Figure 26: Visit of Dr. S.A. Ilangovan, Group Director Chemical Systems Group, PCM Entity, VSSC, Trivandrum and his team to C-MET, Thrissur

Visits Abroad

Dr. N. R. Muniratham, Director General, C-MET and Dr. B. B. Kale Director, C-MET, Pune have visited University College London (UCL), UK during March 18 to 27, 2017 under Indo-UKERI exchange program sponsored by DST.

Figure 27 : Visit of Dr. B. B. Kale and Dr. N. R. Muniurathnam to University College London, UK under Indo-UKERI exchange program with collaborators Dr. Luiza Cintra Campos, Sr. Lecturer in Environmental Engineering and Dr Anna Bogush, co-researcher at UCL

Publications

I) National/ International Patents Awarded

1. Method of producing low loss ceramics, V. Priyadarsini, R. Ratheesh, H. Sreemoolanadhan and S. Chandrasekhar, Indian Patent No. 275251, August 2016.

2. Ceramic filled fluoropolymer compositions, methods and applications thereof, S. Rajesh, K. P. Murali and R. Ratheesh, US patent No. US9455064 B2, September 27, 2016.

3. Ceramic filler, method of preparing ceramic filler and applications as resonator and laminate thereof, R. Ratheesh, K. Stanly Jacob, K. P. Murali, Akhilesh Jain and P. R. Hannurkar, US Patent No. US 9505902 B2, November 29, 2016

4. A filtration apparatus for the removal of oxides during the purification of cadmium, N. R. Munirathnam, D. S. Prasad, T. L. Prakash, Patent Number: 277702 (3191/DEL/2011) November 29, 2016.

National / International Patents Filed

5. Piezoelectric composition, methods and applications thereof, A. Anil, V. Priyadarsini, M. Sathyanarayanan and V. Kumar, US Conventional Patent Application No.15/152674, filed on May 12, 2016.

6. A simple and cost effective process for the preparation of pseudoboehmite from aluminium metal, Sankara Narayanan Potty, Packia Selvam I and Sivadasan A K, Indian Patent Application No. 201611036739 filed on October 26, 2016.

7. Piezoresistor composition and a process for preparing the same, Sunit Rane, Pradhnya Pujari, Govind Umarji, Application No. 201611045089, December 30, 2016.

8. Negative temperature coefficient thermistor composition and a process for preparing the same, Shweta Jagtap, Sunit Rane, Suresh Gosavi, Application No. 201611045045, December 30, 2016.

II) Publications In Peer-reviewed Journals

1. A promising $RVO_4:Eu_4^{3+},Li^+@SiO_2$ (R = Gd, Y and Gd/Y) red-emitting phosphor with improved luminescence (cd/m^2) and colour purity for optical display applications, U. Rambabu, N. R. Munirathnam, B. S. Reddy, S. Chatterjee, Luminescence, 31 (2016) 141-151 (I.F.-1.45).

2. Investigation of Tantalum Recycling by Electron Beam Melting, K. Vutova , V. Vassileva , E. Koleva, N. R. Munirathnam, D. P. Amalnerkar and T. Tanaka, Metals, 6 (2016), 287 (I.F.-1.57)

3. Fern-like rGO/$BiVO_4$ hybrid nanostructures for high-energy symmetric supercapacitor, S. S. Patil, D. P. Dubal, V. G. Deonikar, M. S. Tamboli, J. D. Ambekar, P. Gomez-Romero, S. S. Kolekar, B. B. Kale, D. R. Patil, ACS Applied Materials & Interfaces, 8 (2016) 31602-31610 (I.F.-7.145).

4. Graphene-wrapped $Ag_3PO_4/LaCO_3OH$ heterostructures for water purification under visible light, S. S. Patil, M. G. Mali, A. Roy, M. S. Tamboli, V. G. Deonikar, D. R. Patil, M. V. Kulkarni, S. S. Al-Deyab, S. S. Yoon, S. S. Kolekar, B. B. Kale, Journal of Energy Chemistry, 25 (2016) 845-853 (I.F.-2.322).

5. Synthesis of ultra-small platinum nanoparticles in a continuous flow microreactor, P. L. Suryawanshi, S. P. Gumfekar, P. R. Kumar, B. B. Kale, S. H. Sonawane, Colloid and Interface Science Communications, 13 (2016) 6-9 (I.F.-No IF).

6. Architecture of 2D MoS_2 nanosheets and 3D $CdMoS_4$ marigold flowers: Consequence of annealing on field emission performance, S. R. Kadam, S. R. Suryawanshi, R. P. Panmand, V. R. Mate, M. A. More, D. J. Late, B. B. Kale, Microporous and Mesoporous Materials, 225 (2016) 573-579 (I.F.-3.349).

7. Structural and optical studies of sol–gel dip coated nano-crystalline TiO_2 films, M. T. Sarode, Y. B. Khollam, S. D. Gunjal, P. N. Shelke, B. B. Kale, P. M. Koinkar, K. C. Mohite, Advanced Science Letters, 22 (4), 1089-1092 (2016) (I.F.-No IF)

8. Nano-Scale Mo-MoO_3 entrapped in engineering thermoplastic: Inorganic pathway to bactericidal and fungicidal action, N.M. Qureshi, R. D. Chaudhari, P. C. Mane, M. D. Shinde, S. R. Jadkar, S. B. Rane, B. B. Kale, A. R. Bhalerao, D. P. Amalnerkar, IEEE Transactions on NanoBioscience, 15,3 (2016) 258-264 (I.F.-1.97)

9. Magneto-optic evaluation of antiferromagnetic α-Fe_2O_3 nanoparticles coated on a quartz substrate, S. Balasubramanian, R. Panmand, G. Kumar, S. M. Mahajan, B. B. Kale, SPIE OPTO, 97580O (2016) (I.F.-8.328).

10. Nanosized ZnO under solvent free condition: a smart and ecofriendly catalyst to microwave assisted synthesis of 3, 4-dihydropyrimidin-2(1H)- ones/thiones, S. Shinde, K. Kanade, B. Karale, D. Amalnerkar, N. Thorat, S. Arbuj, S. Kunde, Current Smart Materials, 1 (2016) 68-76. (I.F.-No IF).

11. Sub-micron/nano-scale polymorphs of molybdenum oxide with tuned structural and morphological features embedded in engineering thermoplastic, N. Qureshi, M. Shinde, S. Jadkar, A. Bhalerao, B. Kale, D. P. Amalnerkar, Materials Focus, 5 (2016) 17-23 (I.F.-No IF).

12. Nanostructured layered Sn_3O_4 for hydrogen production and dye degradation under sunlight, S. D. Balgude, Y. A. Sethi, B. B. Kale, N. R. Munirathnam, D. P. Amalnerkar, P. V. Adhyapak, RSC Advances, 6 (2016) 95663-95669 (I.F.-3.289).

13. Ag: $BiVO_4$ dendritic hybrid-architecture for high energy density symmetric supercapacitors, S. S. Patil, D. P. Dubal, M. S. Tamboli, J. D. Ambekar, S. S. Kolekar, P. Gomez-Romero, B. B. Kale, D. R. Patil, Journal of Materials Chemistry B, 4 (2016) 7580-7584 (I.F.-8.262).

14. CO_2 laser direct written MOF-based metal-decorated and hetero-atom doped porous graphene for flexible micro-supercapacitor with extremely high cycling stability, A. Basu, K. Roy, N. Sharma, S. Rane, C. Rode, S. Ogale, ACS Applied Materials & Interfaces, 8, (2016) 31841-31848 (I.F.-7.14).

15. Transition metal ferrocenyldithiocarbamates functionalized dye-sensitized solar cells with hydroxy as an anchoring group, R. Yadav, Y. Waghadkar, G. Kociok-Kohn, A. Kumar, S. B. Rane, R. Chauhan, Optical Materials, 62 (2016) 176-183 (I.F.-2.18).

16. Ferrocenyl chalcones with phenolic and pyridyl anchors as potential sensitizers in dye sensitized solar cells, R. Chauhan, R. Yadav, A. K. Singh, M. Trivedi, G. Kociok-Köhn, A. Kumar, S. Gosavi, and S. Rane, RSC Advances, 6, (2016) 97664-97675 (I.F.-3.289).

17. Synthesis, characterization and tin/copper–nitrogen substitutional effect on photocatalytic activity of honeycomb ordered P2-$Na_2Ni_2TeO_6$, R. Kadari, R. Velchuri, K. Sreenu, G. Ravi, N. R. Munirathnam, M. Vithal, Material Research Express, 3 (2016) 115902 (IF-0.97).

18. Synthesis, characterization and photocatalytic activity studies of tellurium containing defect pyrochlores, $MSn_{0.5}Te_{1.5}O_6$ (M = K, Ag, $Cu_{0.5}$ and $Sn_{0.5}$), R. Guje, R. Gundeboina, R. Kadari, K. Sreenu, CH. S. Reddy, M. Malathi, R. Velchuri, M. Vithal, Indian Journal of Chemistry, 55A (2016) 1174-1181 (I.F.-0.729).

19. Evolution of local structural rearrangements in the complex perovskite $(Ba_{1-x}Pb_x)(In_{0.50}Nb_{0.50})O_3$, A. Anil and V. Kumar, Journal of Americal Ceramic Society, 99 (2016) 3980-3984 (I.F.- 2.787).

20. Influence of defect structure on Ferroelectric aging in donor-acceptor hybrid doped PZT, A. Anil and V. Kumar, Applied Physics A, 122 (2016) 581 (I.F.- 1.694).

21. Heteroepitaxial growth of phase-pure lead indium niobate, A. S. Divya and V. Kumar, Ceramics International, 42 (2016) 12385 (I.F.- 2.758).

22. Composition dependence of transverse piezoelectric properties of preferentially {110}-oriented (1-x) PIN-x PT thin films, S. Laxmipriya, V. Kumar, S. Nishio, I. Kanno, Journal of Alloys Compounds, 688 (2016) 863-867 (I.F.- 3.014).

23. Improved transverse piezoelectric properties in {110}-oriented B-site acceptor doped PLZT(8/65/35) thin films, S. Laxmipriya, V. Kumar, Shogo Nishio, Isaku Kanno, Integrated Ferroelectrics, An International Journal, 176 (2016) 210-219 (I.F.- 0.37).

24. Surface and electrochemical characterization of N-Fe-doped-TiO_2 nanoparticle prepared by hydrothermal and facile electro-deposition method for visible light driven pollutant removal, R. J. Ramalingam, P. Arunachalam, T. Radhika, K. R. Anju, K. C. Nimitha, H A. Al-Lohedan, International Journal of Electrochemical Science, 11 (2016) 10347 – 10361 (I.F.- 1.69).

25. Inkjet printed high-Q RF inductors on paper substrate with ferromagnetic nanomaterial, H. Lee, B. S. Cook, K. P. Murali, M. Raj and M. M. Tentzeris, IEEE Microwave and Wireless Components Letters, 26 (2016) 419-21 (I.F.- 2.236).

26. Novel adsorbent: barleria cristata leaves for removal of methylene blue dye, D. J. Borkar, N. S. Rajurkar and P. V. Adhyapak, Journal of Applicable Chemistry, 5 (2016) 1064-1074 (I.F.-0.654).

27. Elemental profile and Hb content in whole blood of adolescents from baramati region, Pune, Maharashtra, R. S. Kumar, N. S. Rajurkar and P. V. Adhyapak, Journal of Applicable Chemistry, 5 (2016) 886-89 (I.F.-0.654).

28. Bipyramidal and rod like ZnO nanoarchitectures synthesized by precipitation route at different pH for dye sensitized solar cells, N. V. Tellabati, Y. B. Waghadkar , M. D. Shinde, S. B. Rane, S. W. Gosavi and R. Chauhan, Journal of Nanoengineering and Nanomanufacturing, 6 (2016) 114-120 (I.F.-No IF).

29. Coupled semiconductor nanosystems for enhanced photocatalyic applications, S. S. Arbuj, S. B. Rane, Proc. of the Intl. Conf. on Nanotechnology for Better Living, 2016 Editors K. K. Kar, A. Shah and R. Sharma, NBL-2016, 3 (2016) 198 (I.F.-No IF).

30. Kinetics of Hafnium - Zirconium separation in solvent extraction using TBP, R. C. Reddy, A. Kumar, N. R. Munirathnam, Proceedings of the conference on advances in refractory and reactive metals and alloys; Record. 47076189, INIS, 47 (2017) (I.F.-No IF).

31. Template free architecture of hierarchical nanostructured $ZnIn_2S_4$ rose-like flowers for solar hydrogen production, B. B. Kale, A. P. Bhirud, J. O. Baeg, M. V. Kulkarni, Journal of Nanoscience and Nanotechnology, 17 (2017) 1447-1454 (I.F.-1.388).

32. Nanostructured CdS sensitized $CdWO_4$ nanorods for hydrogen generation from hydrogen sulfide and dye degradation under sunlight,Y. A. Sethi, R. P. Panmand, S. R. Kadam, A. K. Kulkarni, S. K. Apte, S. D. Naik, N. Munirathnam, M. V. Kulkarni, B. B. Kale, Journal of Colloid and Interface Science, 487 (2017) 504-512 (I.F.-3.782).

33. V_2O_5 encapsulated MWCNTs in 2D surface architecture: complete solid-state bendable highly stabilized energy efficient supercapacitor device, B. Pandit, D. P. Dubal, P. Gómez-Romero, B. B. Kale, B. R. Sankapal, Scientific Reports, 7 (2017) (I.F.-5.228).

34. Mimics of microstructures of Ni substituted $Mn_{1-x}Ni_xCo_2O_4$ for high energy density asymmetric capacitors, M. S. Tamboli, D. P. Dubal, S. S. Patil, A. F. Shaikh, V. G. Deonikar, M. V. Kulkarni, N. N. Maldar, A. M. Asiri, P. Gomez-Romero, B. B. Kale, D. R. Patil, Chemical Engineering Journal, 307 (2017) 300-310 (I.F.-5.310)

35. Photodynamic effect of light-harvesting, long-lived triplet excited state Ruthenium(II)-polyimine-coumarin complexes: DNA binding, photocleavage and anticancer studies, R. Nomula, X. Wu, J. Zhao and N. R. Munirathnam, Materials Science and Engineering C, 79 (2017) 710-719 (I.F.- 3.42).

36. 1,2-Bis(diphenylphosphino)ethane nickel(II) O,O'-dialkyldithiophosphates as potential precursors for nickel Sulfides, R. Yadav, A. K. Singh, Y. Waghadkar, G. Kociok-Köhn, A. Kumar, R. Chauhan, S. Rane, S. Gosavi,

New Journal of Chemistry, 41 (2017) (I.F.-3.277).

37. Synthesis of SnO/SnO_2 nanocomposites and study of its photocatalytic activity, A. Roy, S. Arbuj, Y. Waghadkar, M. D. Shinde, G. Umarji, S. Rane, K. Patil, S. Gosavi and R. Chauhan, Journal of Solid State Electrochemistry, 21 (2017) 1 9-17 (I.F.- 2.327).

38. Synthesis, charcterization and fabrication of NTC thick film thermistor using lead free glass frit, S. Jagtap, S. Rane, S. Gosavi, Journal of Materials Science and Engineering A & B, 6, (2017) 301-309 (I.F.-No IF).

39. Degradation of organic pollutants by Ag, Cu and Sn doped waste non-metallic printed circuit boards, R. Kadari, R. Velchuri, M. Malathi, M. Vithal, N. R. Munirathnam, Waste Management, 60 (2017) 629-635 (IF – 3.83).

40. Influence of A-site Sr^{2+} substitution on structure, dielectric and ferroelectric characteristics of 0.66[Pb($In_{0.50}Nb_{0.50}$)O_3]-0.34[$PbTiO_3$], A. S. Divya, P. Juairiya, A. Anil, K. Vani, V. Kumar, Ceramics International, 43 (2017) 825-829 (I.F.- 2.758).

41. Influence of defects on the photocatalytic activity of Niobium-doped ZnO nanoparticles, M. K. Satheesan and V. Kumar, Journal of Materials Science: Materials in Electronics, 28 (2017) 4719-4724 (I.F.- 1.798).

42. Crystal structure and microwave dielectric properties of new alkaline earth vanadate ceramics $A_4V_2O_9$ (A=Ba, Sr, Ca, Mg and Zn) for LTCC applications, A. N. Unnimaya, E. K. Suresh and R. Ratheesh, Materials Research Bulletin, 88 (2017) 171-181 (I.F.- 2.435).

43. Synthesis of ultra low temperature sinterable $Na_2Zn_5(MoO_4)_6$ ceramics and the effect of microstructure on microwave dielectric properties, J. Dhanya, A. V. Basiluddeen and R. Ratheesh, Scripta Materialia, 132 (2017) 1-4 (I.F.- 3.305).

44. Effect of annealing temperature on a single step processed Cu_2ZnSnS_4 thin film via solution method, P. Prabeesh, I. P. Selvam, S. N. Potty, Thin Solid Films, 606 (2016) 94–98 (I.F.-1.761).

45. Electrical and optical properties of aluminium doped zinc oxide transparent conducting oxide films prepared by dip coating technique, M. Libu, I. P. Selvam, S. N. Potty, Microelectronics International, 34/1 (2017) 1–8 (I.F.-0.519).

46. Fabrication of CZTS thin films by dip coating technique for solar cell applications, P. Prabeesh, P. Saritha, I. P. Selvam, S. N. Potty, Materials Research Bulletin, 86 (2017) 295–301 (I.F.-2.435).

47. Unique perforated graphene derived from Bougainvillea flowers for high-power supercapacitors: A green approach, R. P. Panmand, P. Patil, S. R. Kadam, M. V. Kulkarni, S. W. Gosavi, N. R. Munirathnam, B. B. Kale, Nanoscale, 9 (2017) 4801-4809 (I.F.-7.76).

48. Nanostructured CdS sensitized $CdWO_4$ nanorods for hydrogen generation from hydrogen sulfide and dye degradation under sunlight, Y. A. Sethi, R. P. Panmand, S. R. Kadam, A. K. Kulkarni, S. K. Apte, S. D. Naik, N. R. Munirathnam, M. V. Kulkarni, B. B. Kale, Journal of Colloid and Interface Science, 487 (2017) 504–512 (I.F.-3.37).

49. Mesoporous cadmium bismuth niobate ($CdBi_2Nb_2O_9$) nanospheres for hydrogen generation under visible light, A. K. Kulkarni, Y. A. Sethi, R. P. Panmand, L. K. Nikam, J. O. Baeg, N. R. Munirathnam, A. V. Ghule, B. B. Kale, Journal of Energy Chemistry, 26 (2017) 433 (I.F.- 2.32).

50. Time-varied synthesis of hierarchical ZnO microspheres and their applications in dye-sensitized solar cells, Y. Waghadkar, M. Shinde, R. Ballal, S. Rane, S. Gosavi, R. Chauhan, Journal of Solid State Electrochemistry, 21 (2017) 1797 (I.F.-2.327).

51. Instantaneous synthesis of faceted nanostructures of iron oxide using microwave solvothermal assisted combustion technique, M. Shinde, N. Qureshi, S. Rane, J. A. Kim, T. Kim and D. Amalnekar, Journal of Nanoscience and Nanotechnology, 17 (2017) 5024 (I.F.-1.388).

52. Hydrogen, ethanol and ammonia gas sensing properties of nano-structured titanium dioxide thick films, S. S. Rane, D. A. Kajale, S. S. Arbuj, S. B. Rane, S. W. Gosavi, J. Materials Science: Materials in Electronics, 28 (2017) 9011 (I.F.-1.79).

III) Presentations In Conferences And Symposia

1. Supercapacitor based Smart Solar Emergency Lighting System, V. Vinith, K. R. Sumesh, A. Chowdhury, P. Bhaskar M, V. Mohan, A. Krishnan, N. R. Panicker, P. A. Abraham, K. Stanly Jacob and N. C. Pramanik, 7th National Conference on New & Renewable Energy Technology (NRET 2016), held at PSG College of Technology, Coimbatore on April 22, 2016.

2. Preparation of high surface area porous carbon from banana stem fibre for EDLC electrode applications, J. Vigneshwaran, K. S. Swathy, K. S. Nisha, P. M. Bhaskar, A. Chowdhury, N. R. Panicker, P. A. Abraham, S. Das and N. C. Pramanik, 7th National Conference on New & Renewable Energy Technology (NRET 2016), held at PSG College of Technology, Coimbatore on April 22, 2016.

3. Purification of Germanium thorough directional solidification and its characterization,V. N. Mani, a paper at International Conference on Advanced Materials and Applications (ICAMA-2016), June 15-17, 2016, BMS College of Engineering, Bangalore.

4. Luminescence optimization with superior aauletric ratio (Rad/opeque) and colour purity of $MBO_3:Eu^{3+}$ (M = Y, Cd and Al) nano down conversion phosphors synthesized by a modified co-precipitation technique, N. R. Munirathnam and U. Rambabu, at IIT Tirupati in c/w International Conference on "Sustainable Energy Technologies for Smart and Clean Cities (SETS & CC-2016)", held at IIT, Tirupati during July 27-29, 2016.

5. Performance characteristics and self discharge of graphene supercapacitors, S. Suraj, A. J. Mejo, M. N. Muralidharan, S. Ansari, International Conference on sustainable Energy Technologies for smart and clean cities, July 27-29, 2016 organized by Indian Institute of Technology, Tirupathi.

6. Fabrication of nanostructured CZTS absorber films by dip coating: Effect of annealing temperature on phase formation, P. Prabeesh, I. P. Selvam, S. N. Potty, International Conference on Sustainable Energy Technologies for Smart and Clean Cities (SETS & CC-2016), held at IIT, Tirupati during July 27-29, 2016.

7. Indigenous development of Aerogel Supercapacitor - an efficient energy storage device for electric vehicles and other advanced electronic applications, A. Chowdhury, P. M. Bhaskar, V. Mohan, N. R. Panicker, P. A. Abraham, K. S. Jacob and N. C. Pramanik, International Conference on Sustainable Energy Technologies for Smart and Clean Cities (SETS & CC-2016), held at IIT, Tirupati during July 27-29, 2016.

8. Integration of aerogel based DSSC with supercapacitor-an approach towards efficient energy management, P. A. Abraham, N. R. Panicker, N. C. Pramanik and K. S. Jacob, International Conference on Sustainable Energy Technologies for Smart and Clean Cities (SETS & CC-2016), held at IIT, Tirupati during July 27-29, 2016.

9. Preparation & characterization of carbon micro-beads for electrochemical flow capacitor applications, P. A. Abraham, N. R. Panicker, N. C. Pramanik and K. S. Jacob, International Conference on Sustainable Energy Technologies for Smart and Clean Cities (SETS & CC-2016), held at IIT, Tirupati during July 27-29, 2016.

10. Environmentally sound methods for the recovery of metals from scrapped printed circuit boards, Parthasarathy, M. R. P. Reddy, S. Chatterjee, Electronics @Car Recycling, ICM AG. November 15-18, 2016, Macau.

11. Silicon carbide (SiC) single crystal bulk growth and challenges – S. Mahajan, M. V. Rokade, S. T. Ali, A. Kumar, N. R. Munirathnam, S. Deb, D. V. S. Rao, L. Durai, B. Srivathsa, P. K. Sahu, S. Saha, V. V. Bhanuprasad, O. P. Thakur and A. K. Garg, a poster presentation in the IUMRS-ICYRAM 2016, held at Indian Institute of Science, Bangalore during December 11-15, 2016.

12. NO_x sensing response of pristine WO_3 and WO_3@ graphene at room temperature, Amruta Rathi, I. S. Mulla, Parag V. Adhyapak XXXV annual conference of Indian Council of Chemist, H. V. Desai College, Pune, December 24, (2016).

13. Biomass derived high surface area activated carbon as an electrode materials for supercapacitor, J. Vigneshwaran, K. S. Swathy, P. M. Bhaskar, A. Krisha, K. R. Sumesh, V. Vinith, A. Chowdhury, P. A. Abraham, N. R. Panicker, K. S. Jacob and N. C. Pramanik, International Conference on Advanced Functional Materials (ICAFM 2017), held at Anna university, Chennai (Guindy Campus), during January 6-8, 2017.

14. Synthesis of hexagonal SnS_2 nanoplates for photocatalytic applications, S. R. Damkale, R. S. Ballal, S. S. Arbuj, S. B. Rane, B. B. Kale, National Conference on Chemistry of Chalcogen (and its nanotechnology) (NC3-2017), Organized by Dept. of Applied Chemistry, DIAT, Pune, January 12-13, 2017.

15. Ferrocenyl chalcones with phenolie and pyridyl anchors as potential sensitizers in dye-sensitized solar cells, R. Chauhan and S. B. Rane, National Conference on Chemistry of Chalcogen (and its nanotechnology) (NC3-2017), Organized by Dept. of Applied chemistry, DIAT, Pune, January 12-13, 2017.

16. Synthesis of TiO_2 nanosheets for photocatalytic H_2 generation, R. Ballal, B. Chavan, S. Damkale, S. Arbuj, S. Rane, B. Kale, National Conference on Chemistry of Chalcogen (and its nanotechnology) (NC3-2017), Organized by Dept. of Applied chemistry, DIAT, Pune, January 12-13, 2017.

17. Matrix studies for solvent extraction of zirconium from hafnium rich zirconium scrub raffinate solution for hafnium enrichment, A. Kumar, M. R. P. Reddy, N. R. Mandre, T. Sharma, a poster presented in International seminar on Mineral Processing technology 2017 organized by Indian Institute of Mineral Engineers at Mahabalipuram, Chennai on February 1-3, 2017.

18. Sol-gel and solid state route synthesis of yttria based composite (Y_2O_3-$YCr_{0.5}Mn_{0.5}O_3$) for thermsitor application. A. Pund, R. Agarkar, M. Shinde, G. Umarji, R. Marimuthu Poster presented in 3rd Mumbai Pune Semiconductor Meeting (MPSM 2017) on February 25, 2017 at Tata Institute of Fundamental Research, Mumbai

19. Synthesis and characterization of yttria based composite (Y_2O_3-$YCr_{0.5}Mn_{0.5}O_3$) for high temperature sensor application (Poster Presented - PP-24 March 3, 2017) A. Pund, R.Agarkar, M. Shinde, G. Umarji, S. Arbuj, R. Marimuthu and S. Rane, Raman Memorial Conference 2017, Department of Physics, Savitribai Phule Pune University, Pune, March 3-4, 2017.

20. Hydrothermally synthesised doped zinc oxide material for photoconductive UV sensor application, Y. Waghadkar, G. Umarji, R. Chauhan, S. Gosavi, S. Rane, 23rd Raman Memorial Conference, Dept. of Physics, Savitribai Phule Pune University, Pune, March, 3-4, 2017.

21. Hydrothermal synthesis and gas sensing response of WO_3 nanoplates, A. B. Rathi, S. B. Karpe, P. V. Adhyapak, Raman Memorial Conference, Department of Physics, Savitribai Phule Pune University, Pune, March 3-4, 2017.

22. Photocatalytic performance of CuO sea-urchins, S. Meshram and P. Adhyapak Raman Memorial Conference, Department of Physics, Savitribai Phule Pune University, Pune, March 3 -4, 2017.

23. Hydrothermal synthesis of pristine and F-doped SnO_2 nanopowders, S. V. Mahale, B. B. Kale, P. V. Adhyapak, Raman Memorial Conference, Department of Physics, Savitribai Phule Pune University, Pune March 3-4, 2017.

24. Heterovalent Sn_3O_4 nanosheets for environmental remediation, S. Balgude and P. Adhyapak, Raman Memorial Conference, Department of Physics, Savitribai Phule Pune University, Pune, March 3 -4, 2017.

25. Design & fabrication of load equalization for supercapacitor bank for application in powering electronics, A. Chowdhury, A. K. Athira, V. Vinith, P. A. Abraham, N. R. Panicker, K. S. Jacob, S. Das, and N. C. Pramanik, International Conference on Advanced Rechargeable Batteries & Allied Materials (ICARBAM 2017), held at Pune during March 8-10, 2017.

26. MO-CAG composites for electrochemical capacitors: Preparation and Studies of energy storage properties, K. S. Swathy, A. Chowdhury, P. A. Abraham, N. Rani Panicker, K. S Jacob and N. C. Pramanik, International

Conference on Advanced Rechargeable Batteries & Allied Materials (ICARBAM 2017), held at Pune during March 8-10, 2017.

27. Preparation of carbon from cheap natural source as a cathode material for lithium ion hybrid electrochemical capacitor, K. S. Jacob, S. N. Tadka, N. R. Paniker, P. A. Abraham and N. C. Pramanik, International Conference on Advanced Rechargeable Batteries & Allied Materials (ICARBAM 2017), held at Pune during March 8-10, 2017.

28. Fabrication and characterization of graphene - polyaniline asymmetric hybrid supercapacitors, S. Suraj, A. J. Mejo, K. A Devi, M. N. Muralidharan and A. Seema, International Conference on Advanced Rechargeable Batteries & Allied Materials (ICARBAM 2017), held at Pune during March 8-10, 2017.

29. Quickly rechargable emergency lamp using graphenesupercapacitor, A. J. Mejo, S. Suraj, M. N. Muralidharan and A. Seema, International Conference on Advanced Rechargeable Batteries & Allied Materials (ICARBAM 2017), held at Pune during March 8-10, 2017.

30. CZTS absorber thin films by spray coating technique, P. Prabeesh, I. P. Selvam, S. N. Potty, International Conference on Advanced Rechargeable Batteries & Allied Materials (ICARBAM 2017), held at Pune during March 8-10, 2017.

31. Spherical hard carbon (SHC) from potato (Root Vegetable) as anode materials for lithium ion battery M. S. Tamboli, A. F. Shaikh, M. R. Mulay, R. P. Panmand, J. D. Ambekar, S. K. Apte, S. D. Naik, R. S. Sonawane M. V. Kulkarni, B. B. Kale, International Conference on Advanced Rechargeable Batteries & allied Materials (ICARBM-2017) held during March 8-10, 2017 at C-MET, Pune.

32. Hydrothermally synthesized dendrite rGO/$BiVO_4$ hybrid nanostructures for high-energy symmetric supercapacitor, V. G. Deonikar, S. S. Patil, J. D. Ambekar, M. V. Kulkarni, B. B. Kale, D. R. Patil, International Conference on Advanced Rechargeable Batteries & allied Materials (ICARBM-2017) held during March 8-10, 2017 at C-MET, Pune.

33. N-ZnO/graphene nanocomposites for high performance supercapacitor, A. P. Bhirud, M. M. Mahadadalkar, S.V. Sadavar, J. D. Ambekar, B. B. Kale, International Conference on Advanced Rechargeable Batteries & Allied Materials (ICARBM-2017) held during March 8-10, 2017 at C-MET, Pune.

34. Nano-structured platinum loaded $CdIn_2S_4$ for photocatalytic solar hydrogen production, M. M. Mahadadalkar, A. P. Bhirud, S. D. Naik, J. D. Ambekar, M. V. Kulkarni, B. B. Kale, International Conference on Advanced Rechargeable Batteries & allied Materials (ICARBM-2017) held during March 8-10, 2017 at C-MET, Pune.

35. Sol-Gel prepared zinc oxide nanowires, A. Bari, P. Bari, R. Bari, L. Patil, J. D. Ambekar, B. Kale, International Conference on Advanced Rechargeable Batteries & Allied Materials (ICARBM-2017) held during March 8-10, 2017 at C-MET, Pune.

36. Ellipsoidal high surface area CuO nanomaterial as an anode material for lithium-ion batteries, G. Lakhotiya, A. Balapure, S. Arbuj, M. Tamboli, B. Kale, International Conference on Advanced Rechargeable Batteries & allied Materials (ICARBM-2017) held during March 8-10, 2017 at C-MET, Pune.

37. Hierarchical 3D metal chalcogenide / graphene nanostructures as an anode for li-ion batteries S. B. Kale, M. M. Mahadadalkar, R. S. Kalubarme, B. B. Kale, International Conference on Advanced Rechargeable Batteries & allied Materials (ICARBM-2017) held during March 8-10, 2017 at C-MET, Pune.

38. Synthesis and characterization of lithium iron phosphate oxide ($LiFePO_4$) nanoparticles as cathode material in li-ion battery applications, A. A. Ambalkar, U. Chothe, C. Ugale, S. Naik, S. Apte, M. V. Kulkarni, B. B. Kale, International Conference on Advanced Rechargeable Batteries & Allied Materials (ICARBM-2017) held during March 8-10, 2017 at C-MET, Pune.

39. Electrochemical evaluation of $LiCoO_2$ synthesized by sol gel method for lithium-ion battery applications. U. Chothe, A. Ambalkar, S. Apte, S. Naik, M. V. Kulkarni, B. B. Kale, International Conference on Advanced Rechargeable Batteries & Allied Materials (ICARBM-2017) held on March 8-10, 2017 at C-MET, Pune.

40. Synthesis of anode material ($Li_4Ti_5O_{12}$) for Li ion battery, R. Ballal, S. Patil, A. Bhirud, M. S. Jayswal, M. Kulkarni, B. B. Kale, International Conference on Advanced Rechargeable Batteries & Allied Materials (ICARBM-2017) held during March 8-10, 2017 at C-MET, Pune.

41. Electrochemical characterization of $Li_4Ti_5O_{12}$ as an anode for Li ion batteries, M. S. Jayswal, A. Bhirud, R. Ballal, M. V. Kulkarni, B. B. Kale, International Conference on Advanced Rechargeable Batteries & Allied Materials (ICARBM-2017) held during March 8-10, 2017 at C-MET, Pune.

42. Li_2MoO_4/C: A novel and high-capacity anode material for a lithium-ion battery, R. P. Panmand, A. Tiwari, T. Aher, S. Dhamale, Y. Sethi, M. V. Kulkarni, N. R. Munirathnam, B. B. Kale, International Conference on Advanced Rechargeable Batteries & Allied Materials (ICARBM-2017) held during March 8-10, 2017 at C-MET, Pune.

43. Synthesis of $LiCoO_2$ structures by spray pyrolysis technique for rechargeable li-ion battery, Y. Sethi, S. Gotherwal, R. Panmand, N. Muniratham, M. V. Kulkarni, B. B. Kale, International Conference on Advanced Rechargeable Batteries & Allied Materials (ICARBM-2017) held during March 8-10, 2017 at C-MET, Pune.

44. Nanowires of Ni substituted $MnCo_2O_4$ as an anode material for high performance lithium-ion battery, A. F. Shaikh, R. S. Kalubarme, M. S. Tamboli, S. S. Patil, M. V. Kulkarni, D. R. Patil, S. W. Gosavi, C.J. Park, B. B. Kale, International Conference on Advanced Rechargeable Batteries & Allied Materials (ICARBM-2017) held during March 8-10, 2017 at C-MET, Pune.

45. Implementation of 3 To 6 series cell lithium-ion battery monitor and secondary protection technique for EV & HEV applications, D. Kajale, A. Kumar, M. V. Kulkarni, B. B. Kale, International Conference on Advanced Rechargeable Batteries & Allied Materials (ICARBM-2017) held during March 8-10, 2017 at C-MET, Pune.

46. Highly flexible liquid-free supercapacitive device modulated through vanadium oxide encapsulated carbon nanotubes, B. Pandit, B. B. Kale, B. R. Sankapal, International Conference on Advanced Rechargeable Batteries & Allied Materials (ICARBM-2017) held during March 8-10, 2017 at C-MET, Pune.

47. Hierarchal PANI-MnO_2 nanocomposite via dynamic interfacial polymerization for electrochemical energy storage, S. M. Thorat, U. V. Kawade, G. M. Thorat, B. B. Kale, M. V. Kulkarni, International Conference on Advanced Rechargeable Batteries & allied Materials (ICARBM-2017) held during March 8-10, 2017 at C-MET, Pune.

48. Novel green synthesis of ternary metal oxides for energy storage applications, M. R. Mulay, V. Deonikar, D. Dubal, D. Patil, M. V. Kulkarni, B. B.Kale, International onference on Advanced Rechargeable Batteries & Allied Materials (ICARBM-2017) held during March 8-10, 2017 at C-MET, Pune.

49. Synthesis and characterization of carbon supported pt catalyst for polymer electrolyte membrane fuel cell, S. Tekale, R. Panmand, S. Kadam, P. Suryawanshi, R. Kumar, S. Sonawane, B. B. Kale, International Conference on Advanced Rechargeable Batteries & Allied Materials (ICARBM-2017) held during March 8-10, 2017 at C-MET, Pune.

50. Combustion synthesis of porous ZnO nanostructures for lithium ion batteries, S. C. Motekar, S. S. Arbuj, G. Umarji, S. Rane, International Conference on Advanced Rechargeable & Allied Materials (ICARBM-2017) held during March 8-10, 2017 at C-MET, Pune.

51. Hexagonal SnS_2 nanoplates as anode material for rechargeable lithium ion batteries, S. Damkale, S. Arbuj, G. Umarji, M. Tamboli, B. Kale and S. Rane, International Conference on Advanced Rechargeable & Allied Materials (ICARBM-2017) held during March 8-10, 2017 at C-MET, Pune.

52. MoO_3-PPS nanocomposite: in-situ generation and superior dielectric performance, N. Qureshi, M. Shinde, M. Kukarni, B. Kale, A. Bhalerao and D. P. Amalnerkar, International Conference on Advanced Rechargeable Batteries & Allied Materials (ICARBM-2017) held during March 8-10, 2017 at C-MET, Pune.

53. Synthesis of ZnO-graphene nanocomposite as advanced anode material for lithium ion batteries, V. Kanade, G. Umarji, M. Tamboli, S. S. Arbuj, S. Rane International Conference on Advanced Rechargeable & Allied Materials (ICARBM-2017) held during March 8-10, 2017 at C-MET, Pune.

IV) Invited Lectures By C-MET Scientists

1. Dr. N. C. Pramanik, "Aerogel Supercapacitors development and the technology status" at the DHI-DST Technology Platform for Electric Mobility (TPEM), held on April 21, 2016 at C-MET, Thrissur.

2. Dr. N. R. Munirathnam delivered an invited talk on "Accrediation facility required for RoHS compliance and samples testing protocols" at C-MET in RoHS awareness program held on May 06, 2016 at Kolkata organized by CII, Kolkata Chapter at The Park Hotel, Kolkata.

3. A scientific Approach for Processing of Electronic Waste and Extraction of Precious Metal Values by Mr. Arbindkumar on June 16, 2016 at Electro-Chemical Society of India seminar in IISc., Bengaluru.

4. Dr. N. R. Munirathnam delivered a Key Note Address on "Indegenization of electronic ceramics for strategic applications" in ACEX-2016 Workshop organized by VSSC on July 14, 2016 at Thiruvnanthapuram, Kerala.

5. Dr. B. B. Kale delivered a talk on Quantum-Dot Glass for Photonic and Energy Applications in ACEX-2016 Workshop organized by VSSC on July 14, 2016 at Thiruvnanthapuram, Kerala.

6. Dr. K. P. Murali delivered an invited lecture at Institute of Engineers, Thrissur Local Office on July 16, 2016 on "Novel Electronics Materials".

7. Dr. N. R. Munirathnam delivered an invited talk on "Electronic waste management for green environment and pollution in smart cities" on July 27, 2016 at IIT Tirupati in c/w International Conference on "Sustainable Energy Technologies for Smart and Clean Cities (SETS & CC-2016)", held at IIT, Tirupati during July 27-29, 2016.

8. Dr. B. B. Kale delivered an Invited talk on "Q-dot based glasses for Energy applications" on July 27, 2016 at IIT Tirupati in c/w International Conference on "Sustainable Energy Technologies for Smart and Clean Cities (SETS & CC-2016)", held at IIT, Tirupati during July 27-29, 2016.

9. Dr. N. C. Pramanik delivered an invited lecture on "Indigenous development of aerogel supercapacitor - an efficient energy storage device for electric vehicles and other advanced electronic applications" on July 27, 2016 at IIT Tirupati in c/w International Conference On Sustainable Energy Technologies For Smart And Clean Cities (SETS & CC-2016)", held at IIT, Tirupati during July 27-29, 2016

10. Dr. U. Rambabu delivered an invited talk on "Restriction of hazardous substances (RoHS), awareness, toxicity, compliance, indian scenario, testing and certification as per E-waste (management) rules, 2016" at International Conference on Sustainable Energy Technologies for Smart and Clean Cities (SETS & CC-2016) during July 27-29, 2016 at Amararaja Batteries, Ltd, Tirupati, A.P.

11. Dr. A. Seema delivered an invited lecture on "NTC thermistors – as thermal sensors", at Department of Chemistry, University of Calicut on July 28, 2016.

12. "Hafnium plant establishment – important considerations" by Mr. Arbind Kumar on July 28, 2017 in Anurag Group of Institutions, Hyderabad.

13. Dr. B. B. Kale delivered a talk at Recent Development of Chemical Sciences as Chief Guest on Nano Composites for Energy Applications at Smt. Kashibai Navale College of Engineering, Sinhgad Road, Vadgaon, Pune on August 27, 2016.

14. Dr. B. B. Kale delivered a talk at International Conference on Impact of Globalization on Crop Cultured and Ethical Issues in Science and Technology at RNC Arts, TDB Commerce and NSC Science College of Nasik on September 15, 2016.

15. Dr. B. B. Kale delivered a talk on Hierarchical Nano Structures for vivid Applications at Nemichand Jain College, Chandwad on September 15, 2016.

16. Dr. N. C. Pramanik delivered an invited lecture on "Advanced materials for electrochemical energy storage" on September 26, 2016 at Thiagarajar College of Engineering (TCE) in c/w International Lecture Workshop (ILW 2016), held at Thiagarajar College of Engineering, Madurai on September 26, 2016

17. Dr. T. Radhika delivered an invited lecture on “CA-Ceramics based flexible films for photochromic applications,” CBPT, Cochin, National Conference, Kerala (September 29-30, 2016).

18. Invited Talk Delivered by Dr. V. N. Mani during International Conference On New Scintillations on Materials Horizon (ICNSMH-2016); October 21-23, 2016, Department of Applied Physics, Faculty of Engineering & Technology, M.J.P. Rohilkhand University, Bareilly.

19. Dr. B. B. Kale delivered a talk at International Conference on Functional Oxides and Nano Materials at Saurashtra University, Rajkot on November 11-13, 2016.

20. Dr. T. Radhika delivered an invited lecture on “Advanced materials for energy harvesting applications”, National Seminar on Advances in Chemistry, Department of Chemistry, Govt. Victoria College, Palakkad, November 29, 2016.

21. Invited Talk Delivered by Dr. V. N. Mani during International Conference on Materials processing and Applications, VIT University, Vellore, December 14-16, 2016.

22. “Coupled semiconductor nanosystems for enhanced photocatalytic applications” delivered by Dr. Sudhir Arbuj on December 16, 2016 at five days workshop on Recent advances in Nanomaterials, Nanotechnology and Nanofabrication organized by Mechanical Engineering Department of Smt. Kashibai Navale College of Engineering, Pune.

23. Dr. B. B. Kale delivered a talk on National Conference of Contribution towards Nano Science at Yashwantrao Chavan Institute of Science, Satara on December 17, 2016.

24. Dr. P. V. Adhyapak has delivered invited talk on “Smart sensors for smart cities” at the XXXV annual conference of Indian Council of Chemists held at H. V. Desai College Pune on December 24, 2016.

25. Dr. A. Seema delivered an invited lecture on “Graphene sensors and actuators”, National Seminar on Nanomaterials and its Advances in Chemical and Life Sciences during January 5-6, 2017 at St. Xavier College for Women, Aluva, Kerala.

26. Dr. T. Radhika delivered an invited lecture in “National seminar on recent advances in chemistry”, on Solar energy harvesting materials and its applications at Department of Chemistry, Vimala College, Thrissur, January 9, 2017.

27. Dr Girish Phatak delivered an Invited talk entitled "Advanced electronic packaging and materials", on January 16, 2017 at One week Faculty Development Training Programme on “Advances in Engineering Materials and Testing Techniques”, Organized by Mechanical Engg. Department, Government Polytechnic, Pune during January16-20, 2017.

28. Dr. Y. Purushotham delivered an invited lecture on “Development of high pure zinc for detector applications” in an International Conference on “Environmental Impact of Advanced Materials and Energy Technologies” (EIAMET 2017), during January 19-21, 2017, at Hyderabad.

29. Dr. K. P. Murali delivered an invited lecture on First National Symposium under TEQUIP-II on “Advanced materials & processing” on January 20, 2017 at Mechanical Engineering Department, Govt. Engineering College, Sreekrishnapuram.

30. Dr. N. R. Munirathnam delivered a talk on “Accrediation facility required for RoHS compliance and samples testing protocols” at C-MET in RoHS awareness programs held on January 25, 2017 at Pune organized by CII, Pune Chapter at Sun-N-Sand Hotel, Pune.

31. Dr. B. B. Kale delivered a talk at the Convocation Ceremony at All India Shri Shivaji Memorable Society's – College of Engineering, Pune on January 27, 2017.

32. Dr. B. B. Kale delivered a talk on Nano Structured Materials for Energy Application at Swami Ramananda Tirtha University, Nanded on February 05, 2017.

33. Dr. N. C. Pramanik delivered an invited lecture on “Advanced electrochemical capacitors – potential energy storage for the next generation power electronics” on February 04, 2017 at Dept. of Physics, CUSAT in c/w National Workshop on 'Contemporary Advances in Materials for Energy 2017', held at CUSAT (Cochin) during February 3-4, 2017.

34. Dr. V. Kumar delivered an invited lecture on “Nanomaterials for device applications” at the National Workshop on Nanomaterials and Nanocomposites held at Amrita Viswavidyapeetam, Coinbatore on February 4, 2017.

35. Dr. V. Kumar delivered an invited Prof. K. P. Antony Memorial Lecture on “Chemistry of materials”, at the National Seminar on Frontiers in Applied Chemistry, St.Thomas College, Thrissur on February 7, 2017.

36. Dr. R. Ratheesh delivered plenary lecture on “Ultra low loss dielectric ceramics and composites for microwave circuit applications" in the 2nd International Conference on Alumina and Other Functional Ceramics (AOFC-2017), CGCRI, CSIR, Kolkotta on February 15, 2017.

37. Dr. B. B. Kale delivered a talk at the Graduation Ceremony as Guest of Honor at MIT, Kothrud, Pune on February 28, 2017.

38. Dr. S. N. Potty delivered an invited lecture on “Basics of X-ray diffraction”, Inaugural lecture in the National Science Day celebration at Sree Krishna College, Guruvayur on March 1, 2017.

39. Dr. S. N. Potty delivered an invited lecture on “Different sources of Energy”, State Institute of Correctional Administration (SICA), Thrissur on March 2, 2017.

40. Invited talk delivered by Dr V. N. Mani on “Purification and characterization of select gallium based GaSb and GaN materials for high-end optoelectronic applications-a bird's eye view”, XXI National Seminar on Crystal Growth and Applications (XXI NSCGA-2017); March 6-8, 2017, PG and Research Department of Physics, National College, Tiruchirappalli.

41. Dr. B. B. Kale delivered a talk on Nano Structured Materials and Nano Composites at University College of London, United Kingdom on March 21, 2017.

42. Dr. V. Kumar delivered Keynote address on “Defect chemistry: a goldmine for tailoring materials”, at the National Seminar on Frontiers in Chemistry, Calicut University, Calicut on March 29, 2017.

43. Dr. U. Rambabu, has delivered an invited talk on “E-waste managements and recycling technologies” on March 30, 2017 at the 4th National Seminar on waste management, conducted by Dr. B. R. Ambedkar open University, Dept. of Geology, Faculty of Science, Hyderabad.

V) Awards and Honours

1 . Dr. Y. Purushotham was elected as Fellow of the Telanagana Akademi of Sciences (FTAS) for the year 2016.

2. Dr. Parag V. Adhyapak was elected as Fellow of Maharashtra Academy of Sciences (November 9, 2016).

3. Dr. Sunit B. Rane was elected as Fellow of Maharashtra Academy of Sciences (November 9, 2016).

4. BEST POSTER award for the poster presentation entitled “Silicon carbide (SiC) single crystal bulk growth and challenges”, S. Mahajan, M. V. Rokade, S. T. Ali, A. Kumar, N. R. Munirathnam, S. Deb, D. V. S. Rao, L. Durai, B. Srivathsa, P. K. Sahu, S. Saha, V. V. Bhanuprasad, O. P. Thakur and A. K. Garg; IUMRS-ICYRAM 2016 held at Indian Institute of Science, Bangalore during December 11-15, 2016.

5. Mrs. Amruta Rathi received the “Woman Scientist” award for the best oral presentation at XXXV Annual Conference of Indian Council of Chemist, (December 24, 2016).

6. Synthesis of hexagonal SnS_2 nanoplates for photocatalytic applications, Shubhangi R. Damkale, Reshma S. Ballal, Sudhir S. Arbuj, Sunit B. Rane, Bharat B. Kale, National Conference on Chemistry of Chalcogen (and its nanotechnology) (NC3-2017) Organized by Dept. of Applied Chemistry, DIAT, Pune, January 12-13, 2017 (2nd Best Poster presentation Prize)

7. Ferrocenyl chalcones with phenolie and pyridyl anchors as potential sensitizers in dye-sensitized solar cells", Ratna Chauhan and Sunit B. Rane, National Conference on Chemistry of Chalcogen (and its nanotechnology) (NC3-2017) Organized by Dept. of Applied chemistry, DIAT, Pune, January 12-13, 2017 (Consolation Prize)

8. Poster presentation entitled "Preparation and studies of electrochemical properties surface modified carbon aerogel for EDLC applications", M. P. Bhaskar, Vasanth Mohan, Abhishek Chowdhury, Sumesh K. R, P. A. Abraham, Rani Panicker N, Stanly Jacob K, and N. C. Pramanik, in International Conference on Advanced Rechargeable Batteries & Allied Materials (ICARBAM 2017)", held at Pune during March 8-10, 2017 received Best Poster Award.

VI) Technical Report

1. Single Crystal Silicon Carbide Boule Growth Process Demonstration – S. Mahajan, M. V. Rokade, S. T. Ali, P. K. Sahoo, D. Kumar, S.Saha, S. Deb, L. Durai, V. V. V. S. Subba Rao, V. V. Bhanuprasad, D. V. Sridhara Rao, A. Pandey, A. K. Kapoor, O. P. Thakur and A. K. Garg, report in DRDO-DMRL-EMG-144-2016**.**

Others

Plans And Prospects

C-MET implemented the projects in accordance with its approach and strategy. The key features of plans and prospects are:

1. To enhance the competency in advanced areas of science and technology in order to keep pace with the world scenario of electronic materials through *in-house* and *grant-in-aid* projects with inter and intra laboratory involvement.

2. Continue the interactive/ working relation with strategic sector for development of critical materials through sponsored projects.

3. Continue the technical services and materials characterization services to industries for creating more scope for consultancy projects and RoHS certification and allied services for improvement in revenue earnings.

4. Be a front runner in R&D of Electronics Materials and collaborate with esteemed international and national institutes/universities for creating common platform on knowledge sharing basis.

5. Development of impactful products and technologies through exploratory and applied research.

Acknowledgment

C-MET is grateful to the Ministry of Electronics & Information Technology (Meity), Govt. of India for its whole-hearted support and guidance during the entire year. It is my pleasure to acknowledge the support to C-MET in the form of specific sponsored projects for the technology/product development from the government and private organizations such as MeitY, ISRO (VSSC) , DST, DRDO, DAE (BRNS), EATON Pvt Ltd, Modison Metals Ltd, etc.

The guidance and proactive support of the Honourable Chairman, Deputy Chairman, Executive Vice-Chairman and Members of the Governing Council of C-MET has been invaluable for effective functioning. The advice of the Steering and Executive Committee of C-MET in carrying out the programmes effectively and efficiently requires special mention. I sincerely thank all of them.

I place on record very special thanks to all the Officers and Staff members of Electronic Materials and Components Development (EMCD) Division, Finance Division, Autonomous Bodies Coordination Division (ABCD) and the other divisions of MeitY, for their extraordinary support and prompt co-operation in implementing C-MET's programs. I am also obliged to our bankers, Punjab National Bank, Canara Bank, State Bank of India, Indian Overseas Bank, Andhra Bank and Bank of India at Pune, Hyderabad and Thrissur for rendering timely services.

I earnestly owe all the staff members and project staff working in various projects of C-MET for their dedicated professional efforts in the R&D activities, administrative services and financial support in achieving the overall progress of C-MET during the year.

Dr. N. R. Munirathnam
Director General
On behalf of C-MET Team

Major Characterisation Equipments Available At C-MET

C-MET, Pune

Name of The Equipment	Model	Name of The Manufacturer	Applications
UV-VIS Spectrometer	UV 3600	Hitachi, Japan	Spectroscopic Chemical Analysis
Spectrofluorometer	JOBIN YVON F3	Horiba, Japan	Defects in semiconducting materials
Photo Luminescence Spectrometer	RF-5301	Shimadzu, Japan	Luminescence studies of organic, inorganic and polymeric compounds
Potentiostat/ Galvanostat	PGstat 100	Autolab, Netherlands	Electrochemical Synthesis and Characterization
TGA/SDTA/ DSC/DPA	Toledo 821, 851	Mettler, Switzerland	Thermal Characterization of Organic, Inorganic and polymeric samples
TMA/DMA	Perkin Elmer 7e	Perkin Elmer, USA	Thermomechanical Analysis of Polymers
Fourier Transform Infrared Spectrometer (FTIR)	PE Spectrum 2000	Perkin Elmer, USA	Spectroscopic Chemical Analysis
Scanning Electron Microscope (SEM) with EDAX	Philips XL-30	Philips, Netherlands	Surface Morphology and related Microanalysis
Graphite furnace Atomic Absorption Spectrometer	Avanta - sigma	Nulab, USA	Trace Impurity Analysis
Hot Stage Microscope	FP-900, Lica DMLP	Mettler- Toledo, Switzerland	Characterisation of Liquid Crystalline Polymers
Scanning Probe Microscope (SPM)	Pico plus	Agilent Technologies Inc., USA	Examination of Topological Features at Atomic Scale
Field Emission Scanning Electron Microscope (FE-SEM)	S-4800 II	Hitachi, Japan	Surface Morphology and related Microanalysis
Field Emission Transmission Electron Microscopy (FE-TEM)	JSM 2200FS	JEOL, Japan	Surface Morphology and related Microanalysis
Broadband Impedance Spectrometer	C80	Nova Control	Frequency sweep measurements of dielectric properties and conductivity of materials

C-MET, Hyderabad

Name of The Equipment	Model	Name of The Manufacturer	Applications
Inductively coupled Plasma Mass spectrometer (ICP-MS)	X-Series II	Thermo Fisher Scientific, Germany	Elemental Analysis in liquid (ppb/ppt level)
Inductively Coupled Plasma Optical Emission Spectrometer (ICP-OES)	iCAP 6500 series	Thermo Fisher Scientific, Germany	Elemental analysis in liquid at ppm level at for Hafnium facility
X-Ray Diffractometer (XRD)	Xpert PRO	PANALYTICAL, Netherlands	Phase and impurities detection in materials
Inductively Couples Plasma Optical Emission Spectrometer (ICP-OES)	Agilent 725	Agilent Technologies India Pvt. Ltd., Bangalore	Elemental analysis in liquid at ppm level at RoHS facility
Gas Chromatograph Maas spectrometer (GC-MS)	DSQ II	Thermo Fisher Scientific, USA	Analysis of Poly bromibated compounds in electronic materials
Energy Dispersive X-ray Flourescence (ED XRF)	ARL Quanta X	Thermo Fisher Scientific, USA	Screening of elemental analysis down to ppm level
Ion Chromatography (IC)	850 IC Professional	METROHM, Switzerland	Estimation of Anions/ Cations
Graphite Furnace Atomic Absorption spectroscopy (GF AAS)	GF3000/93 2AA	GBC, Australia	Elemental analysis at ppm/ ppb level in liquids
Microwave Digestion System for RoHS facility	Multiwave-3000	ANTON PAAR, Vienna	Closed Digestion of samples by Microwave
Microwave Digestion System for hafnium facility	Star D	MILESTONE, Italy	Closed Digestion of samples by Microwave
Water purification System	Purelab Classic	ELGA, U.K.	18.2 MΩ water for analysis at RoHS facility
Metallurgical Microscope	LABORLUX 12 ME ST	LEICA, Germany	Morphological and Structural Analysis of Materials
Carbon Sulphur analyzer	EMIA-920V2	HORIBA, Japan	Estimation of Carbon, Sulphur in Metal Samples
Micro Hardness Tester	HMV	SHIMADZU, Japan	Measuring Brinell Rockwell, Diamond Hardness
ONH Analyser	ONH-836	LECO, USA	Estimation of Oxygen, Notrogen and Hydrogen in materials
Water Purification system	SA 67120	Millipore, USA	18.2 MΩ water for analysis
UV Visible Spectrophotometer	UV 2450	SHIMADZU, Japan	Organic & Inorganic Analysis of Elements in liquids (micro level)
TGA/DTA	S-II 7300	S-II, Nano Technology, Japan	Thermal Characterization of Organic, Inorganic and polymeric samples $\leq 1400\ ^{0}C$
ED-XRF	EPSILON I,	Panalytical, Holland.	Elemental analysis Na to U, in PCB, intermediates, slag
Microwave Digestion System	STAR D	Milestone, Italy	Sample preparation for ICP OES
Fire Assay System	CF-15	Carbolite, UK	Estimation of precious metal

C-MET, Thrissur

Name of The Equipment	Model	Name of The Manufacturer	Applications
DSC/TGA	SDTQ600	TA Instruments, USA	To study Physicochemical changes with respect to temperature upto 1500^{0}C
Impedance Analyser	HP4192A	Hewlett-Packard, Japan	To measure inductance, capacitance, resistance, factor and variation of these properties with frequency from 5Hz to 13 MHz.
BET Surface Area Analyser	Nova 1200	Quantachrome, USA	Measurements of surface area of nano powders
Supercapacitor Test Systems	BT-2000	Arbin Instruments, USA	Measurement of capacitance, ESR, charge-discharge cycle
Gain Phase Analyser	Model 4294A	Agilent Technologies, USA	For impedance analysis of materials in the frequency range 40hz to 110MHz
Electrometer	6517A	Keithley, USA	Measurement of electrical resistivity (10 to 210T) voltage / current, RH, etc.
Vector Network Analyzer	E8263 B	Agilent Technologies, USA	Microwave characterization of Dielectric Resonators, Composite substrates, ferrites, tunable dielectrics etc.
Piezo evaluation system	FE 2000	AixACCT, Germany	For piezoelectric property evaluation
Thermo Mechanical Analyzer	TMA/SS6100	SII, Japan	Measurement of thermal expansion coefficient of materials
UV-Visible Spectrophotometer	Lambda 35	Perkin Elmer, USA	For measuring the absorbance in the UV-Visible region
BET surface Area Analyser	Quadrasorb-Evo-KR/MP	M/s Quantachrome Instruments, USA	Surface area and Pore size distribution of porous materials
Helium Pycnometer	Ultrapyc1200E	M/s Quantachrome Instruments, USA	To determine skeletal density of porous materials
Rheometer	DHR-2	M/s TA Instruments, USA	Rheological Analysis of Fluids, Pastes etc
FTIR	Spectrum 10	M/s Perkin Elmer, USA	IR spectroscopy to study the chemical environments of species
SEM with EDS	EVO 18	M/s Carl Zeiss	Microstructural and elemental analysis of materials

C-MET, PUNE

AUDITED
FINANCIAL STATEMENTS
FOR THE YEAR
2016-2017

M/S. P. N. Phadke & Co.

Chartered Accountants

103, Megh Apts, S. No. 39/33, Opp. Ayurved Ras-shala,
Off. Karve Road, Pune - 411 004.

INDEPENDENT AUDITOR'S REPORT TO THE CENTRE FOR MATERIALS FOR ELECTRONICS TECHNOLOGY (C-MET)

Report on the Financial Statements

We have audited the accompanying financial statements of **Centre for Materials for Electronics Technology, C-MET**, which comprise the Balance Sheet as at 31st March, 2017, and Income & Expenditure Account for the year then ended, and a summary of the significant accounting policies and other explanatory information.

Management's Responsibility for the Financial Statements

The Management of Centre for Materials for Electronics Technology, is responsible for the preparation of these financial statements that give a true and fair view of the financial position and financial performance in accordance with the Accounting Standards applicable to non corporate entities issued by Institute of Chartered Accountants of India in accordance with the accounting principles generally accepted in India. This responsibility includes the design, implementation and maintenance of internal control relevant to the preparation and presentation of the financial statements that give a true and fair view and are free from material misstatement, whether due to fraud or error.

Auditors' Responsibility

Our responsibility is to express an opinion on these financial statements based on our audit. We conducted our audit in accordance with the Standards on Auditing issued by the Institute of Chartered Accountants of India. Those Standards require that we comply with ethical requirements and plan and perform the audit to obtain reasonable assurance about whether the financial statements are free from material misstatement.

An audit involves performing procedures to obtain audit evidence about the amounts and the disclosures in the financial statements. The procedures selected depend on the auditor's judgment, including the assessment of the risks of material misstatement of the financial statements, whether due to fraud or error.

In making those risk assessments, the auditor considers internal control relevant to the Society's preparation and presentation of the financial statements that give a true and fair view in order to design audit procedures that are appropriate in the circumstances. An audit also includes evaluating the appropriateness of the accounting policies used and the reasonableness of the accounting estimates made by the Management as well as evaluating the overall presentation of the financial statements.

We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our audit opinion.

Opinion

In our opinion and to the best of our information and according to the explanations given to us, the aforesaid financial statements read with Annexure to Audit Report and Notes to Accounts (schedule 6) annexed herewith give a true and fair view in conformity with the accounting principles to the extent applicable to the Society:

a) in the case of the Balance Sheet, of the state of affairs of the Society as at 31st March, 2017; an
b) in the case of the Income & Expenditure Account, of the deficit of the Society for the year ended on that date;

For P. N. Phadke & Co.
Chartered Accountants
Firm Registration No.107890W

CA V. P. Phadke
Membership No. 100811
(PARTNER)

Place : Pune.
Date : 05/07/2017

ANNEXURE Forming part of the Audit Report
of Centre for Materials for Electronics Technology
for the Year ended 31st March 2017.

1) Fixed Assets pertaining to projects:

At present, the fixed assets pertaining to projects are shown in the books as project expenses. As suggested, project fixed assets are shown separately in the Balance Sheet.

In respect of those assets, which relate to the projects that are completed and the fixed assets which are not likely to be returned to the sponsorers, feasibility to dispose off such assets may be assessed.

2) Valuation of Inventory:

Pursuant to the management policy with regard to valuation of lab-wares, chemicals and consumables, the purchases are charged to consumption irrespective of stock thereof at the end of the year. We are of the opinion that the stock at the end of the year may be valued and brought into account.

3) Prior period income and expenditure:

Expenses amounting to Rs 10,58,659/- pertaining to previous year have been accounted for in the current year.

4) Contingent liability :

Contingent liability not provided in the books of account:-

Particulars	Current Year ₹	Previous year ₹
For Capital goods	Nil	Nil
For Others (In respect of pending Court Matter)	81,533.00	81,533.00

For P. N. Phadke & Co.
Chartered Accountants
Firm Registration No.107890W

CA V. P. Phadke
Membership No. 100811
(PARTNER)

Place : Pune
Date : 05/07/2017

CENTRE FOR MATERIALS FOR ELECTRONICS TECHNOLOGY, PUNE.

BALANCE SHEET AS AT 31st MARCH, 2017

(Amount ₹)

CORPUS / CAPITAL FUND AND LIABILITIES :	Schedule	As at 31.3.2017	As at 31.3.2016
CORPUS / CAPITAL FUND	*1*	477,738,865	460,843,842
CURRENT LIABILITIES AND PROVISIONS (Including sponsored project)	*2*	405,668,623	400,820,267
TOTAL		**883,407,488**	**861,664,109**
ASSETS :			
FIXED ASSETS	*3*	160,790,205	134,428,070
CURRENT ASSETS, LOANS AND ADVANCES	*4*	722,617,283	727,236,039
MISCELLANEOUS EXPENDITURE (to the extent not written off or adjusted)		-	-
TOTAL		**883,407,488**	**861,664,109**
SIGNIFICANT ACCOUNTING POLICIES	*5*		
NOTES TO ACCOUNTS AND CONTINGENT LIABILITIES	*6*		

We hereby certify the above balance sheet to be true & correct to the best of our knowledge & belief, subject to notes to accounts and schedules attached hereto.

sd/-
Dr. N. R. Munirathnam
Director General

sd/-
G. B. Rao
Sr. Finance Officer

As per our report of even date attached.
For P. N. Phadke & Co.
Chartered Accountants
F.R. No. 107890W

sd/-
CA V. P. Phadke
(M.No.: 100811)
(PARTNER)

PLACE: PUNE
DATE : 05/07/2017

Centre for Materials for Electronics Technology, Pune.

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31st MARCH, 2017

(Amount ₹)

INCOME :	Schedule	Current Year 2016 - 17	Previous Year 2015 - 16
Revenue Grants	7	79,767,874	102,056,137
Income from Services	8	17,591,838	19,977,802
Interest Earned	9	35,111,521	28,312,918
Other Income	10	1,501,070	342,458
TOTAL (A)		**133,972,303**	**150,689,315**
EXPENDITURE :			
Establishment Expenses	11	110,404,374	102,238,927
Laboratory and Administrative Expenses etc.	12	33,035,041	38,821,923
Depreciation		23,869,991	22,320,745
TOTAL (B)		**167,309,406**	**163,381,595**
Surplus / (Deficit) for the year (A - B)		(33,337,103)	(12,692,280)
Balance transferred to/from Corpus/Capital Fund		(33,337,103)	(12,692,280)

We hereby certify the above Income & Expenditure account to be true & correct to the best of our knowledge & belief, subject to notes on accounts and schedules attached hereto.

sd/-
Dr. N. R. Munirathnam
Director General

sd/-
G. B. Rao
Sr. Finance Officer

As per our report of even dated attached
for P. N. Phadke & Co.
Chartered Accountants
F.R. No. 107890W

sd/-
CA V. P. Phadke
(M.No.: 100811)
(PARTNER)

PLACE: PUNE
DATE : 05/07/2017

CENTRE FOR MATERIALS FOR ELECTRONICS TECHNOLOGY, PUNE

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31st MARCH, 2017

(Amount ₹)

SCHEDULE 1 : **CORPUS / CAPITAL FUND :**	**As at 31.3.2017**		**As at 31.3.2016**	
Balance as at the beginning of the year	384,380,258		380,436,395	
Add: Contribution towards Corpus/Capital Fund	50,232,126		3,943,863	
	434,612,384		384,380,258	
Add / (Less) : Balance of net income / Expenditure transferred from Income and Expenditure Account :				
As per last year	76,463,584		89,155,864	
Add : Surplus / (Deficit) for the year	(33,337,103)		(12,692,280)	
	43,126,481	477,738,865	76,463,584	460,843,842
BALANCE AT THE YEAR END		**477,738,865**		**460,843,842**

SCHEDULE 2 : CURRENT LIABILITIES AND PROVISIONS :

(Schedules Forming Part of Balance Sheet as at 31st March, 2017)

(Amount ₹)

A. CURRENT LIABILITIES :	**As at 31.3.2017**		**As at 31.3.2016**	
1. Sundry Creditors :				
a) For goods & others	59,918		182,589	
b) For E.M.D and Deposits	4,295,515	4,355,433	2,606,800	2,789,389
2. Statutory Liabilities :				
Profession Tax / ITDS / Service Tax / GIS		290,668		262,826
3. Other Current Liabilities :				
Sponsored Projects	269,647,798		292,277,220	
Other Liabilities	38,232,582	307,880,380	24,294,438	316,571,658
TOTAL (A)		**312,526,481**		**319,623,873**
B. PROVISIONS :				
1. Gratuity Payable	47,531,981		43,842,949	
2. Leave Encashment payable	36,430,225		34,391,000	
3. C-MET CPF Trust	-		455,942	
4. Expenses Payable	9,179,936	93,142,142	2,506,503	81,196,394
TOTAL (B)		**93,142,142**		**81,196,394**
TOTAL (A + B)		**405,668,623**		**400,820,267**

Centre for Materials for Electronics Technology, Pune

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31st MARCH, 2017

SCHEDULE 3 : Fixed Assets :

(Amount ₹)

DESCRIPTION	GROSS BLOCK				DEPRECIATION				NET BLOCK	
	As at 1.4.2016	Additions during the year	Deletions/ Adj. during the year	**As at 31.03.2017**	As at the beginning of the year	For the year	Deletions/ Adj. during the year	**Total upto 31.03.2017**	**AS AT 31.03.2017**	As at 31.3.2016
1. BUILDINGS ON FREEHOLD LAND	82,235,843	40,908,788		123,144,631	54,301,023	6,642,406		60,943,429	62,201,202	27,934,820
2. LAB EQUIPMENT	292,090,902	7,139,188	166,762	299,063,328	195,197,743	15,162,058		210,359,801	88,703,527	96,893,159
3. FURNITURE, FIXTURES	12,563,806	182,866	756	12,745,916	8,913,016	377,427		9,290,443	3,455,473	3,650,790
4. OFFICE EQUIPMENT	15,623,286	922,485	23,635	16,522,136	12,064,112	654,644		12,718,756	3,803,380	3,559,174
5.COMPUTER/ PERIPHERALS	11,268,402	574,494		11,842,896	10,477,119	785,779		11,262,898	579,998	791,283
6. ELECTRIC FITTINGS	1,079,926	695,458		1,775,384	575,818	85,616		661,434	1,113,950	504,108
7. ELECTRIC SUBSTATION	3,689,196	-		3,689,196	2,871,670	122,629		2,994,299	694,897	817,526
8. AIR CONDITIONERS	813,174	-		813,174	578,955	35,133		614,088	199,086	234,219
9. TUBEWELL	95,494	-		95,494	52,503	4,299		56,802	38,692	42,991
TOTAL OF CURRENT YEAR	**419,460,029**	**50,423,279**	**191,153**	**469,692,155**	**285,031,959**	**23,869,991**	**-**	**308,901,950**	**160,790,205**	**134,428,070**

Centre for Materials for Electronics Technology, Pune

SCHEDULE 4 : CURRENT ASSETS, LOANS & ADVANCES :

(Schedules forming part of Balance Sheet as at 31st MARCH, 2017)

(Amount ₹)

	As at 31.3.2017		As at 31.3.2016	
A. CURRENT ASSETS:				
1. Cash balances in hand		1,751		9,710
2. Bank Balances with Scheduled Banks :				
- On Deposit Accounts	285,818,811		251,628,773	
- On Savings Accounts	100,237,838		98,291,734	
- Project Deposits (Including FLC Margin money)	261,451,040	647,507,689	244,639,682	594,560,189
TOTAL (A)		**647,509,440**		**594,569,899**
B. LOANS, ADVANCES AND OTHER ASSETS				
Loans and Advances to Staff	322,751		286,800	
Loans and Advances to Others	47,669,938		51,966,382	
Amount Recoverable	2,003,552		239,869	
Advance to Suppliers	4,253,449		52,828,368	
Security and Other Deposits	14,806,294		23,240,106	
Prepaid Expenses	14,813		17,889	
Interest Accrued on FDRs	6,037,046	75,107,843	4,086,726	132,666,140
TOTAL (B)		**75,107,843**		**132,666,140**
TOTAL (A + B)		**722,617,283**		**727,236,039**

CENTRE FOR MATERIALS FOR ELECTRONICS TECHNOLOGY (C-MET), PUNE

Schedules forming part of the Accounts for the year ended 31st March 2017

SCHEDULE: 5 SIGNIFICANT ACCOUNTING POLICIES

1. Accounting Conventions :

The Financial Statements are prepared on historical cost convention, going concern, and accrual basis and the same are followed consistently, except for Bonus, which is accounted for on cash basis. Bonus is not provided for in the financial year 2016-17, as it is not declared for Autonomous Bodies, as decided by the Government of India.

2. Revenue Recognition :

- Income from operation includes, Income from analysis receipts, overhead receipts and Professional/consultancy services. Income from these activities is accounted for as and when services are rendered.
- Grants are recognized when there is a reasonable assurance that, the grants will be received.
- C-MET being research body, its entire expenditure relates to research activity. The expenditure incurred is debited to the appropriate accounts.
- All significant items of incomes and expenses are accounted on accrual basis unless otherwise stated.

3. Fixed Assets :

- Fixed Assets stated in the Balance Sheet are valued at their cost of acquisition inclusive of freight, octroi and other direct and indirect cost in respect thereof except incase of Thrissur Laboratory, where the assets written off during the year are reduced from Gross block at net W.D.V.
- Society has been directed to charge depreciation on its assets on the written down value basis vide instructions issued by Ministry of Information Technology. Accordingly, depreciation has been charged as per rates prescribed under the Income Tax Act, 1961.
- Fixed Assets procured under the Sponsored projects, being the property of the respective Sponsoring agency, are not accounted under the head C-MET Fixed Assets.

4. Inventory :

As per the policy consistently followed by the Centre, expenditure incurred on consumable stores and spares is charged to revenue account.

5. Foreign Currency Transaction :

Transactions in foreign currency are recorded at the exchange rates prevailing on the date of transactions. Foreign Currency Assets / Liabilities are restated at the rates prevailing at the year end. Exchange Differences relating to fixed assets are adjusted to the cost of the assets. Any other exchange difference is dealt with in the Income & Expenditure Account.

6. Prior period and Extraordinary Items :

Prior period income and expenses and extraordinary items, wherever material are disclosed separately.

Prior period items include material items of Income or Expenses which arise in the current period as a result of error or omission in the preparation of financial statements of one or more prior periods. It does not include items, which are ascertained and determined during the year.

7. Retirement Benefits:

C- MET has set up Contributory Provident Fund separately. Leave Encashment and Gratuity is accounted for as per the actuarial valuation, liability whereof is as below :

a) **Gratuity** **- ₹ 4,75,31,981/-** **(Previous year ₹ 4,38,42,949/-)**

b) **Leave Encashment** **- ₹ 3,64,30,225/-** **(Previous year ₹ 3,43,91,000/-)**

8. Amount equal to capital expenditure is credited to capital fund. Grants for sponsored projects are shown separately. Grant received for the project are shown in the Balance Sheet and the expenses incurred for the project are debited to such projects. Thus, unspent amount of the sponsored projects is shown as liability.

For **CENTRE FOR MATERIALS FOR ELECTRONICS TECHNOLOGY**

sd/-
Dr. N. R. Munirathnam
Director General

sd/-
G. B. Rao
Sr. Finance Officer

for P. N. Phadke & Co.
Chartered Accountants
F.R. No. 107890W

sd/-
CA V. P. Phadke
(M. No.: 100811)
(PARTNER)

PLACE: PUNE
DATE : 05/07/2017

CENTRE FOR MATERIALS FOR ELECTRONICS TECHNOLOGY (C-MET), PUNE

Schedules forming part of the Accounts for the year ended 31st March 2017

SCHEDULE: 6 NOTES ON ACCOUNTS

1. Current Assets, Loans & Advances: In the opinion of the management, the current assets, loans and advances have a value on realization in the ordinary course of business equal at least to the aggregate amount shown in the Balance Sheet.
2. Foreign Currency Transactions:
   a) Value of Imports (FOB basis):
      Capital Goods: Rs. 3,28,56,269/- (Previous Year Rs. 3,54,76,154/-)
   b) Expenditure in Foreign Currency: Rs.22,04,587.63 (Previous Year Rs. 23,10,691.16/-)

   As the information of CIF basis for import of capital goods is not available, values are taken on FOB basis.
3. Estimated amount of contingent liability carried forward towards pending court judgement for medical reimbursement of Thrissur laboratory staff is Rs. 81,533/- (Previous Year Rs. 81,533/-)
4. The Society is an approved institution in terms of sub-section (21) of section 10 of the Income Tax Act, 1961 and is exempt from tax.
5. Since most of the materials/equipments are of technical nature, their allocation between equipments, stores and projects is taken as certified by the management.
6. C-MET, being a scientific Society and not a commercial, industrial or a business entity, the Management is of the opinion that reporting requirements as per AS-17 " Segment Reporting" are not mandatory.
7. The Management of C-MET is of the opinion that being a Scientific Society under Ministry of Electronics and Information Technology, Govt. of India and Societies Registration Act, the disclosure requirement as per AS-18 "Related Party Disclosure" are not applicable.
8. In case of project undertaken by C-MET Hyderabad (SP-22 & TS001) the balance as on 31.03.2017 are combined.
9. The TDS is deducted only at the time of payment and not on the amount provided for in books of accounts in Hyderabad.
10. C-MET has received a sum of Rs. 6776000/- from Railways towards compensation for part of the land acquired. However it is informed that the same is not income and the said amount is a liability returnable to the Parent Ministry who owns the land.
11. In the opinion of the Management, Accounting Standard 22 for "Accounting for taxes on income" is not applicable to the Society as it is exempt from payment of income tax.
12. Debit and Credit Balances of Personal Accounts are subject to confirmation.
13. Previous years figures have been regrouped and rearranged wherever necessary.
14. In case of ITC (Input tax credit) of service tax the amounts appearing in financial accounts and returns submitted with tax authorities are subject to reconciliation.
15. Schedules 1 to 11 are annexed to and form an integral part of the Balance Sheet as at 31st March, 2017 and the Income & Expenditure Account for the year ended on that date.

For CENTRE FOR MATERIALS FOR ELECTRONICS TECHNOLOGY

sd/-
Dr. N. R. Munirathnam
Director General

sd/-
G. B. Rao
Sr. Finance Officer

for P. N. Phadke & Co.
Chartered Accountants
F.R. No. 107890W

sd/-
CA V. P. Phadke
(M.No.: 100811)
PARTNER

PLACE: PUNE
DATE : 05/07/2017

Centre for Materials for Electronics Technology, Pune

Schedules forming part of Income & Expenditure A/c for the year ended 31st March, 2017

(Amount ₹)

SCHEDULE 7 : REVENUE GRANTS	Current Year 2016-17	Previous Year 2015-16
Grants for Revenue Expenditure.	79,767,874	102,056,137
TOTAL	**79,767,874**	**102,056,137**

SCHEDULE 8 - INCOME FROM SERVICES	Current Year 2016-17	Previous Year 2015-16
Income from Services:		
Analysis receipts	873,445	1,075,464
Overhead / Consultancy Services / Int. Fee	15,619,893	17,300,338
ToT Fee	1,098,500	1,602,000
TOTAL	**17,591,838**	**19,977,802**

SCHEDULE 9 : INTEREST EARNED	Current Year 2016-17	Previous Year 2015-16
On Savings account and Term Deposits :		
a) With Scheduled Banks	35,102,492	28,292,131
b) On Advances to Staff	9,029	20,787
TOTAL	**35,111,521**	**28,312,918**

SCHEDULE 10 : OTHER INCOME	Current Year 2016-17	Previous Year 2015-16
Miscellaneous Income	1,501,070	342,458
TOTAL	**1,501,070**	**342,458**

Centre for Materials for Electronics Technology, Pune

Schedules forming part of Income & Expenditure A/c for the year ended 31st March, 2017

(Amount ₹)

SCHEDULE 11 : ESTABLISHMENT EXPENSES	Current Year 2016 -17	Previous Year 2015-16
Salaries and Allowances	87,856,113	83,077,710
Bonus	-	233,481
Training	27,298	-
Leave Travel Concession	1,379,611	436,325
Medical Reimbursement	4,557,297	4,609,351
Leave Encashment	4,461,186	3,512,048
Gratuity	6,287,071	4,355,528
Employer Contribution to CPF & Interest	2,933,398	3,552,529
NPS Contribution	766,279	-
Honorarium	57,579	80,362
Canteen Reimbursement	902,120	944,680
Newspaper & Periodicals	131,170	83,738
CEA Reimbursement	1,010,481	1,284,603
Membership Fees	25,695	42,037
Recruitment Expenses	9,076	26,535
Transfer TA	-	-
TOTAL	**110,404,374**	**102,238,927**

Centre for Materials for Electronics Technology, Pune

SCHEDULE 12 : LABORATORY AND ADMINISTRATIVE EXPENSES

(Schedules Forming Part of Income & Expenditure A/c for the year ended 31st March, 2017)

(Amount ₹)

Particulars	Current Year 2016-17	Previous Year 2015-16
Chemicals	575,784	607,985
Laboratory Consumables	1,313,322	2,335,784
Laboratory General expenses	217,456	5,465,119
Electricity charges	12,130,772	9,222,906
Water charges	154,090	168,319
Repairs and maintenance :		
On Buildings	208,419	284,029
On Electricals	319,695	503,577
On Laboratory Equipments	1,358,698	1,417,496
On Office Equipments	306,858	424,784
On Furniture & Fittings	-	7,004
Rates and Taxes	1,499,593	1,373,030
Postage & Telegram Charges	88,581	102,138
Telephone & Fax charges	484,531	501,392
Printing and Stationery	615,666	720,458
Conveyance	12,772	29,123
Vehicle Hire	1,716,954	1,499,263
TA & DA	1,915,291	1,485,502
Security Expenses	3,744,611	4,098,565
Office & General Expenses	2,460,486	5,244,285
Diesel for Gensets	223,964	386,723
Auditor's Remuneration	138,250	107,175
Audit Expenses	72,767	82,944
Meeting Expenses	583,835	1,197,433
Foreign Tour Expenses	-	-
Gardening Expenses	696,222	663,019
Bank charges	33,061	12,690
Advertisement and Publicity	193,598	129,692
Professional & Consultancy charges	62,000	32,345
Prior period Expenses	1,054,382	67,789
Foundation Day Expenses	-	515,768
Workshop/Symposia	16,100	7,000
TOT Expenses	-	661
Contribution to Sponsored project	554,930	126,925
Assets written off	191,153	-
Legal Expenses	91,200	1,000
TOTAL	**33,035,041**	**38,821,923**

Centre for Materials for Electronics Technology, Pune

DETAILS OF PROJECT BALANCES AS ON 31st March, 2017

(Amount ₹)

Sr. No.	Project Name		Opening Balance as on 1.4.2016	Receipts during the year 2016-17	Payments during the year 2016-17			Closing Balance as on 31.3.2017
					Fixed Assets	Other Expenses	Total	
	1		2	3	4	5	6 = (4+5)	7 = (2+3-6)
	PUNE							
1	SP22	TiO2 Phosphate Glass	5,214	-	-	5,214	5,214	-
2	SP24	X-ray Absorbing -DIT	202,371	-	-	202,371	202,371	-
3	SP26	Micro-cantilever proj.	80	-	-	-	-	80
4	SP28	Solar light photocatalyst	(211,501)	-	-	-	-	(211,501)
5	SP29	Q-semiconductor Glass	(634,827)	634,827	-	-	-	-
6	SP30	LTCC Project-BARC	27	-	-	-	-	27
7	SP32	Adv. Process capabilities in LTCC	593,516	-	-	593,517	593,517	(1.00)
8	SP33	Devp. Of LTCC Sys for Cryocooler Appl	11,066	28,895	-	-	-	39,961
9	SP36	Solar Hydrogen production	(26,870)	27,000	-	130	130	-
10	SP39	Devp. Of Optical Isolators	(5,431)	-	-	-	-	(5,431)
11	SP40	Devp of Prototype X-ray Apron	183,799	-	-	183,799	183,799	-
12	SP41	UGC-JRF- JM Malli	63,629	-	-	-	-	63,62
13	SP42	Bismuth Sulphide quantum Dot glass	372,657	-	-	-	-	372,657
14	SP43	In House Devp of Photoconducting Paste (DIT)	175,430	-	-	175,430	175,430	-
15	SP44	Devp of Photo-Reactor	(207)	207	-	-	-	-
16	SP45	Devp of LTCC Materials for GPA	35,154,124	5,312,947	15,519,087	622,946	16,142,033	24,325,038
17	SP46	CSIR-SRF-Ms. Bhirud	36,518	-	-	-	-	36,518
18	SP47	CSIR-JRF-Mr. Pandit	33,999	566,000	-	225,072	225,072	374,927
19	SP48	INSPIRE FACULTY AWARD-Dr.Chauhan	456,212	1,302,798	61,900	1,433,462	1,495,362	263,648
20	SP49	Devp. Of Active Material	23,967,656	6,417,269	16,692,467	8,479,588	25,172,055	5,212,870

Centre for Materials for Electronics Technology, Pune

DETAILS OF PROJECT BALANCES AS ON 31st March, 2017

(Amount ₹)

Sr. No.	Project Name		Opening Balance as on 1.4.2016	Receipts during the year 2016-17	Payments during the year 2016-17			Closing Balance as on 31.3.2017
					Fixed Assets	Other Expenses	Total	
	1		2	3	4	5	6 = (4+5)	7 = (2+3-6)
21	SP50	CSIR-JRF-MS A F Shaikh	30,113	630,333	-	623,821	623,821	36,625
22	SP51	Devp. Of Visible Light	463,172	664,868	35,333	1,092,515	1,127,848	192
23	SP52	Fab. Of Microwave Components	-	378,141	-	-	-	378,141
24	SP53	INDO-UKIERI Programme with NCL	110,152	18,135	-	216,466	216,466	(88,179)
25	SP54	Prototype Devp of Fuel Cell	695,905	1,084,800	-	889,678	889,678	891,027
26	SP55	Inspired Faculty Award-D R Patil	579,724	1,442,724	-	1,495,436	1,495,436	527,012
27	SP56	UGC-JRF-Trupti Nirmale	28,073	-	-	28,073	28,073	-
28	SP57	Devp of Nanostructured PdTe	388,010.00	363,721	-	714,071	714,071	37,660
29	SP58	Synth and Charact of Condtor Polymer	706,267.00	351,285	290,250	483,458	773,708	283,844
30	SP59	Proof of Patternable Thick film	5,104,540.00	224,458	-	857,597	857,597	4,471,401
31	SP60	Devp. Of Electrolyte systems		4,714,117		939,660	939,660	3,774,457
32	SP61	FAB of 2D Heterostructures		2,812,875		187,875	187,875	2,625,000
33	SP62	SERB Young Scientist Dr Khupse		1,290,000			-	1,290,000
34	TS04	Scaleup of colour Glass	217,922	-	-	217,922	217,922	-
35	TS07	LTCC Packages for MEMS-JCDA	1,465,308	593,517	1,384,418	3,960	1,388,378	670,447
36	TS09	LTCC Packages thin film devices	599,442	-	-	138,944	138,944	460,498
37	TS10	Devp. Of Microwave Compenents in LTCC	3,187	-	-	-	-	3,187
38	TS11	Study on Synthesis of nano	45,560	6,360	-	27,270	27,270	24,650
39	TS12	LTCC Based Circuits Fittings	(11,713)	-	-	-	-	(11,713)
40	TS13	LTCC Based Magnectic Sensor	1,029,259	4,299,961	978,226	1,649,169	2,627,395	2,701,825
41	TS14	Low Temp Co-Fired Ceramic	1,232,767	-	111,500	913,604	1,025,104	207,663

Centre for Materials for Electronics Technology, Pune

DETAILS OF PROJECT BALANCES AS ON 31st March, 2017

(Amount ₹)

Sr. No.	Project Name	Opening Balance as on 1.4.2016	Receipts during the year 2016-17	Payments during the year 2016-17			Closing Balance as on 31.3.2017
				Fixed Assets	Other Expenses	Total	
	1	2	3	4	5	6 = (4+5)	7 = (2+3-6)
42	TS15 Devp of Microcrystaliine	-	1,839,304		484,684	484,684	1,354,620
	TOTAL (a)	73,065,150	35,004,542	35,073,181	22,885,732	57,958,913	50,110,779
	HYDERABAD						
43	SP22 Establishment of extended pilot plan…annum hafnium sponge	8,865,641	-	1,299,582	7,566,059	8,865,641	-
44	SP28 Germanium -DAE	1,255,756	-	-	-	-	1,255,756
45	SP29 RoHS-TEST LAB-DIT	4,943,634	5,770,000		5,924,734	5,924,734	4,788,900
46	SP30 SERB-SP	5,229	900,000	-	801,016	801,016	104,213
47	SP31 GALLIUM-DST	5,192,709	-	-	277,336	277,336	4,915,373
48	SP32 E-WASTE-PCBs-DeitY	38,422,524	10,005,000	2,945,169	9,938,153	12,883,322	35,544,202
49	SP33 DRDO/SSPL/CARS/Cd & Te	2,051,470	-	-	1,316,398	1,316,398	735,072
50	SP34 Photosensitizers for visible light -SERB	1,633,333	-	-	834,378	834,378	798,955
51	SP35 SiC / DMRL	-	62,045,978	22,294.00	8,040,887	8,063,181	53,982,797
52	SP36 CFLs & FLs / DST	-	2,176,200	-	529,575	529,575	1,646,625
53	SP37 Recycling scrap Germanium DRDO SSPL	-	8,160,630	-	1,147,351	1,147,351	7,013,279
54	SP38 Ultra High Pure Zn BRNS IGCAR	-	2,240,000	-	61,764	61,764	2,178,236
55	TS-01 Hafnium VSSC	-	18,166,734	-	15,435,934	15,435,934	2,730,800
	TOTAL (b)	**62,370,296**	**109,464,542**	**4,267,045**	**51,873,585**	**56,140,630**	**115,694,208**
	THRISSUR :						
56	SP45 Devp. of LTCC materials ….applications	197,583	633,010	-	588,401	588,401	242,192
57	SP46 Devp of Titania Aerogel…Solar cell appl.	153,934	-	-	153,934.00	153,934	-

Centre for Materials for Electronics Technology, Pune

DETAILS OF PROJECT BALANCES AS ON 31st March, 2017

(Amount ₹)

Sr. No.	Project Name	Opening Balance as on 1.4.2016	Receipts during the year 2016-17	Payments during the year 2016-17			Closing Balance as on 31.3.2017
				Fixed Assets	Other Expenses	Total	
	1	2	3	4	5	6 = (4+5)	7 = (2+3-6)
58	SP47 BRNS(AS)	123,556	93,759	-	217,315	217,315	-
59	SP48 BRNS(RR)	127,734	-	-	127,734	127,734	-
60	SP49 DST(SNP)	591,777	71,332	-	556,337	556,337	106,772
61	SP50 DIETY(AS)	1,450,101	438,850	-	1,888,951	1,888,951	-
62	SP51 DIETY(AS)	1,250,377	3,520,559	-	3,656,134	3,656,134	1,114,802
63	SP52 BRNS(RT)	1,051,714	386,994	943,666	462,832	1,406,498	32,210
64	SP53 BRNS(RR)	2,883,343	2,632,310	-	2,852,106	2,852,106	2,663,547
65	SP54A DIETY(NCP)	73,717,186	763,492	9,022,905	2,019,003	11,041,908	63,438,770
66	SP54B DST(NCP)	60,641,725	16,621,185	57,197,308	2,350,734	59,548,042	17,714,868
67	SP55 BRNS(NR)	(74,144)	917,709	-	641,330	641,330	202,235
68	SP56 BRNS(NCP)	13,347,079	223,163	-	1,182,147	1,182,147	12,388,095
69	SP57 SERB(NR)	1,137,822	316,980	-	1,179,514	1,179,514	275,288
70	SP58 MD Substrates (Meity)	-	6,177,902	374,102	437,900	812,002	5,365,900
71	GIA-III JRF- Ms. VANI K	-	-	-	-	-	-
72	GIA-IV JRF- Ms. DIVYA A S	29,341	-	-	-	-	29,341
73	GIA-V JRF- Ms. VIJYA K	157,723	-	-	147,542	147,542	10,181
74	GIA-VI JRF- Ms. LAXMI PRIYA	42,421	-	-	42,421	42,421	-
75	GIA-VIII JRF- MR. MANOJ N	1,239	396,361	-	388,990	388,990	8,610
70	-- -- DISHA Programme	-	250,000	-	-	-	250,000
71	-- -- KSCSTE FELLOWSHIP- MR. ANIL A	11,263	84,647	-	95,910	95,910	-
	TOTAL (c)	**156,841,774**	**33,528,253**	**67,537,981**	**18,989,235**	**86,527,216**	**103,842,811**
	GRAND TOTAL (a+b+c)	**292,277,220**	**177,997,337**	**106,878,207**	**93,748,552**	**200,626,759**	**269,647,798**

Centre for Materials for Electronics Technology, Pune

RECEIPTS AND PAYMENTS FOR THE YEAR ENDED 31st March, 2017

(Amount ₹)

RECEIPTS	Current Year 2016-17	Previous Year 2015-16	PAYMENTS	Current Year 2016-17	Previous Year 2015-16
I. Opening Balances			**I. Payments**		
a) Cash in Hand	9,710	10,627	Establishment		
b) Bank Balances :			Expenses	103,533,348	95,114,022
i) Saving Account	98,291,734	79,627,645			
ii) In Fixed Deposits	251,628,773	273,456,400	Administrative		
iii) In Project &			Expenses	32,397,380	38,878,263
Others Deposits	244,639,682	204,364,448			
			II.Project Payments		
			Sponsored Projects	101,955,343	74,112,005
II. Grants Received			**III.Fixed Assets**		
a) From DeitY, G.o.I.			Purchase of Fixed		
Capital Grants	5,778,967	3,943,863	Assets	50,423,279	3,943,863
Revenue Grants	124,221,033	102,056,137	Capital Work in		
			Progress		
III. Interest on Deposits					
On Bank Deposits	32,280,545	27,829,842	**IV.Other Payments**		
			Loans & Advances to		
			staff & others	27,775,655	53,093,652
IV. Other Income					
Analysis Income	832,195	1,096,914	**V.Closing Balances**		
Miscellaneous Receipts	63,341,243	20,649,884	a) Cash in Hand	1,751	9,710
			b) Bank Balances :		
			i) In Savings accounts	100,237,838	98,291,734
			ii) In Fixed Deposits	285,818,811	251,628,773
			iii) In Project &		
			others Deposits	261,451,040	244,639,682
V. Other Receipts					
Sponsored Project					
Receipts	127,498,875	135,839,030			
Loans & Advances					
from staff & others	15,071,688	10,836,914			
TOTAL	**963,594,445**	**859,711,704**	**TOTAL**	**963,594,445**	**859,711,704**

Statement showing comments of the Statutory Auditors on the accounts of C-MET for the year 2016-2017 and C-MET's replies thereto

<table>
<tr><th>Sr.</th><th>Brief Subject</th><th>Auditor's Comments</th><th>C-MET Reply</th></tr>
<tr><td>1.</td><td>Fixed Assets pertaining to projects</td><td>At present, the fixed assets pertaining to projects are shown in the books as project expenses. As suggested project fixed assets are shown separately in the Balance Sheet.

In respect of those assets, which relate to the projects that are completed & the fixed assets which are not likely to be returned to the sponsorers, feasibility to dispose off such assets may be assessed.</td><td>Actual amount of Fixed Assets procured out of the projects is separately accounted for & indicated in the schedule. Also individual headwise expenditure is separately maintained and sent to Sponsoring Agency. In addition, project Fixed Assets register is also maintained.
Ownership and title of project fixed assets rests with the project sponsoring agency.
Fixed Assets pertaining to completed projects are disposed off as soon as sponsoring agency consents their disposal.</td></tr>
<tr><td>2.</td><td>Valuation of Inventory</td><td>Pursuant to the management policy with regard to valuation of lab-wares, chemicals and consumables, the purchases are charged to consumption irrespective of stock thereof at the end of the year. We are of the opinion that the stock at the end of the year needs to be valued and brought into account.</td><td>Consumable materials like lab-ware, chemicals etc. are purchased according to actual & current needs and immediately sent to the respective laboratory for use. Hence there is no retaining store system. Therefore, valuation of consumable stores by the storekeeper is not feasible.</td></tr>
<tr><td>3.</td><td>Prior period income and expenditure</td><td>Expenses for ₹ 10,58,659/- of previous year have been accounted for in the current year.</td><td>For information only.</td></tr>
<tr><td>4.</td><td>Contingent Liability</td><td>Contingent liability not provided in the books of account :-
In ₹
<table><tr><th>Particular</th><th>Current Year</th><th>Previous Year</th></tr><tr><td>For Capital goods</td><td>Nil</td><td>Nil</td></tr><tr><td>For Others</td><td>81,533.00</td><td>81,533.00</td></tr></table></td><td>For information only.</td></tr>
</table>

Notes

Notes

Steering and Executive Committee of C-MET (2016-2017)

STEERING COMMITTEE

Prof. T. R. N. Kutty — Chairman
Emeritus Professor, IISC
No. 48, HMT Layout, 7th Cross/ 7th Main
Rebindranath Tagore Nagar (PO)
Bangalore - 560 012

Dr. Debashis Dutta — Member
Group Coordinator (R& D Electronics),
Ministry of Electronics & Information Technology
Electronics Niketan, 6, CGO Complex,
New Delhi - 110 003

Prof. S. B. Krupanidhi — Member
Materials Research Centre
Indian Institute of Science
Bangalore - 560 012

Dr. J. Narayana Das — Member
Chief Controller (R&D) DRDO (Retd),
Sarovar, D-4, Fact Nagar, Tripunithura

Dr. S. Arvamuthan — Member
Dy. Director
PPCM, VSSC
I. S. R. O. (P.O.)
Thiruananthapuram - 695 014

Dr. Murali Sastry — Member
CEO,
IITB-Monash research Academy,
IIT, Powai
Mumbai - 400 076

Prof. N. S. Gajbhiye — Member
Professor in Chemistry
Depart of Chemistry
Indian Institute of Technology Kanpur
Kanpur - 208016

Dr. N. R. Munirathnam — Member-Convenor
Director General
Centre for Materials for Electronics Technology
Panchawati, Off Pashan Road
Pune - 411 008

EXECUTIVE COMMITTEE

Dr. N. R. Munirathnam — Chairman
Director General
Centre for Materials for Electronics Technology
Panchawati, Off Pashan Road, Pune - 411 008

Dr. Pradeep Chopra — Member
Scientist 'G' and Head EM&C Division
Minsitry of Electronics & Information Technology
Electronics Niketan, 6 CGO Complex
New Delhi - 110 003

Shri R. P. Pradhan — Member
Director (Societies)
Ministry of Electronics & Information Technology
Electronics Niketan, 6, CGO Complex
New Delhi - 110 003

Smt. C. K. Bajaj — Member
DFA (Finance)
Ministry of Electronics & Information Technology
Electronics Niketan, 6, CGO Complex
New Delhi - 110 003

Dr. B. B. Kale — Member
Director
Centre for Materials for Electronics Technology
Panchawati, Off Pashan Road, Pune - 411 008

Dr. Arbind Kumar — Member
Director (A)
Centre for Materials for Electronics Technology
Hyderabad - 500 051 (upto 6th November 2016)

Dr. R. Ratheesh — Member
Director
Centre for Materials for Electronics Technology
Hyderabad - 500 051 (from 7th November 2016 onwards)

Dr. V. Kumar — Member
Director (A)
Centre for Materials for Electronics Technology
Thrissur - 680 771 (upto 21st September 2016)

Dr. N. Raghu — Member
Director
Centre for Materials for Electronics Technology
Thrissur - 680 771 (22nd September 2016 onwards)

Dr. Tanay Seth — Member
Programme Co-ordinator
Centre for Materials for Electronics Technology
Panchawati, Off Pashan Road, Pune - 411 008

Shri G. B. Rao — Member
SFO
Centre for Materials for Electronics Technology
Panchawati, Off Pashan Road, Pune - 411 008

Dr. N. Raghu — Member Secretary
Registrar (Acting)
Centre for Materials for Electronics Technology
Panchawati, Off Pashan Road, Pune - 411 008

Inaugural Function of the Annual Foundation Day 2017

From Left: Dr. Milind Kulkarni, Convenor, Prof. Orlando Auciello, USA, Dr Vijay Bhatkar, Chancellor, Nalanda University, Dr. R. A. Mashelkar, National Research Professor and President, Global Research Alliance, Dr. Debashis Dutta, Group Coordinator, MeitY, N. R. Munirathnam, Director General, C-MET and Dr. B. B. Kale, Director, C-MET, Pune.

CENTRE FOR MATERIALS FOR ELECTRONICS TECHNOLOGY (C-MET)

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