Ministry of Electronics and Information Technology
Government of India

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CONFERENCE REPORT

International Conference on Purification and Recycling of Electronic Materials (ICPREM-2020)

Venue: Marriott Courtyard, Hyderabad

Organized By:

Centre for Materials for Electronics Technology (C-MET)

Ministry of Electronics and Information Technology (MeitY), Govt. of India

IDA Phase-III, HCL Post, Cherlapally, Hyderabad-500 051, Telangana, INDIA

www.cmet.gov.in

Introduction

An International conference on Purification and Recycling of Electronic Materials (ICPREM-2020) was conducted at Centre for Materials for Electronics Technology (C-MET), Hyderabad during March 8 to 10, 2020 in conjunction with 29th C-MET Annual Foundation Day to review the sustainable e-waste management and processing of substantial volumes of Waste Electrical & Electronic Equipment generated due to demand in strategic, commercial and societal electronics. The conference has been turned out as a link between different national and international R&D and industrial sectors with wide intellectual discussions. The invited speakers from National and International R&D Labs/Universities and entrepreneurs were delivered thought provoking lectures with core theme of the conference. The lectures delivered in this conference exemplified a range of foundry models based on ultra purification, recovery of precious metals from spent PCBs and sustainable e-waste management.

Purpose

The conference was convened to bring together scientists, technologists and entrepreneurs actively engaged in the area of e-waste processing to understand and propagate ideas on technological challenges for sustainable development.

Objectives

Conference objectives focused on the following subtopics.

- Purification, processing and characterization of electronic materials
- High pure materials and their compounds for optoelectronic applications
- E-Waste (Management) Rules 2016
- E-waste recycling processes
- Resource efficiency & circular economy
- Artificial intelligence and machine learning in e-waste management

PROGRAM SCHEDULE

8th MARCH 2020

08.30-09.30 Registration

INAUGURAL SESSION

09.30-12.00 Invocation & Lighting of Lamp
Welcome address: Dr. R. Ratheesh, Director, C-MET, Hyderabad
Address by Dr. N. R. Munirathnam, Director General, C-MET
Address by Prof. Animesh Jha, University of Leeds, UK
Address by Dr. Sandip Chatterjee, Scientist F and Director, MeitY, New Delhi
Guest of Honour address: Prof. B. S. Murty, Director, IIT Hyderabad
Chief Guest address: Dr. G. Satheesh Reddy, Secretary, Department of Defense R&D and Chairman, DRDO
Address by (through video conference):
Shri Ajay Sawhney, IAS, Secretary, MeitY, Govt. of India
Release of ICPREM-2020 Souvenir
Handing over of 7N pure Germanium to SSPL, DRDO
Achievements of C-MET in a cursory glance:
Dr. N. R. Munirathnam, Director General, C-MET
Vote of thanks:
Dr. Y. Purushotham, Convener, ICPREM - 2020

FOUNDATION DAY LECTURE

12.00-13.00 Extraction of rare-earth oxides from titaniferous and monazite concentrates and their importance in the energy devices and systems
Prof. Animesh Jha, University of Leeds, UK

INVITED LECTURES

14.00-14.45 Invited Lecture 1:
Life cycle thinking for sustainable E-waste management
Prof. Marlia Mohd Hanafiah, Universiti Kebangsaan Malaysia, Malaysia

14.45-15.30 Invited Lecture 2:
Sustainable Environment friendly Electronics Waste Recycling
Dr.Sandip Chatterjee, Ministry of Electronics & IT, New Delhi, India

16.00-16.45	Invited Lecture 3: End to end process and technology development for ultra-high purity germanium crystalline materials **Dr. R. Radhakrishnan Sumathi**, IKZ, Berlin, Germany
16.45-17.30	Invited Lecture 4: EBIC and DLTS characterization of semiconductor materials **Prof. Eugene B Yakimov**, Russian Academy of Sciences, Chernogolovka, Russia

9th MARCH 2020

09.30-10.15	Invited Lecture 5: Recycling of precious metals from electronic industries **Dr.P.Parthasarathy**, E-Parisaraa Pvt Ltd, Bengaluru, India
10.15-11.30	Invited Lecture 6: Modular solutions for metal recovery from PCB scrap **Dr. Uttam Doraswami**, Elxion Pvt Ltd, Bengaluru, India
11.45-12.30	Invited Lecture 7: Recovery of minor and strategic metals from base metals waste streams **Dr. B K Gorian**, Hindusthan Zinc Limited, Udaipur, India and **Dr. V I Lakshmanan**, Process Research Ortech, Ontaria, Canada
12.30-13.15	Invited Lecture 8: Opportunities, challenges & trends in Lithium ion battery recycling in India **Dr. Debraj Mishra**, Sungeel India Recycling Pvt Ltd, Hindupur, AP, India
14.15-15.00	Invited Lecture 9: Ultrapurification and characterization of High Purity Materials **Shri K V Mirji**, Nuclear Fuel Complex, Hyderabad, India
15.00-15.45	Invited Lecture 10: Eco and environmental benefits of recovery of metals from printed circuit boards over traditional metallurgical process with particular reference to – Aluminium, Copper, Silver and Gold **Prof Keshav A. Bulbule,** Consultant, E-Parisaraa Pvt Ltd, Bengaluru, India
16.00-17.00	**POSTER PRESENTATION**
17.00-17.30	**PANEL DISCUSSION & CONCLUDING SESSION**

10th MARCH 2018

Visit to C-MET Hyderabad Laboratory

Welcome address by Dr. R. Ratheesh, Director, C-MET Hyderabad

Dr. R. Ratheesh, Director, C-MET Hyderabad welcomed the Honourable guests Dr. G. Satheesh Reddy, Secretary, Department of Defense R&D and Chairman DRDO, Prof. B S Murty, Director, Indian Institute of Technology Hyderabad, Prof. Animesh Jha, University of Leeds, UK, Dr. Sandip Chatterjee, Scientist F and Director, Ministry of Electronics and Information Technology (MeitY), New Delhi and Dr. N. R. Munirathnam, Director General, C-MET to the dais and all the other distinguished delegates gathered for International Conference on Purification and Recycling of Electronic Materials (ICPREM-2020). Further, he congratulated all woman participants from different continents of the world on the occasion of International Women's Day. ICPREM-2020 was inaugurated with invocation song by Ms. Y. Suhasini & Mr. Y. Vishnuvardhan and lighting of the lamp by women delegates in the presence of honourable guests.

Honourable Guests on the Dais

Invocation Song

Lighting of Lamp

Chief Guest address: Dr. G. Sateesh Reddy, Secretary, Department of Defence R&D and Chairman, DRDO

Secretary, Department of Defence R&D and Chairman, DRDO, Dr. G. Sateesh Reddy delivered the Chief Guest address on the occasion of 29th annual foundation day celebrations of C-MET and ICPREM-2020 at Hyderabad. While addressing the conference, he stressed on the viable technologies for recycling of end of life electrical & electronic gadgets. He appreciated C-MET for developing and supplying 99.99999% (7N) ultrapure Germanium, Cadmium and Tellurium to Solid State Physics Laboratory, DRDO for various strategic applications. He opined that India should create a materials bank and march forward with futuristic and commercially viable technologies ahead of the global competitors.

He deliberated mainly on the importance of critical indigenous electronic materials technologies developed by C-MET, which are essential to the progress of the country. Indigenous processes for the purification of strategic metals is a major milestone in achieving self-reliance in homeland security. Recycling of electronic waste at the end of its life cycle is also an important step towards retaining valuable precious metals and in maintaining the hazardous free environment and safety of living beings on globe. As on date, most of the critical materials that defence needed are to be imported from the foreign sources due to the slow pace in the development of innovative research, cost effective technologies and design know-how for up scaling to pilot plants. At times they are banned to supply due to their strategic importance. He also emphasized that indigenous cost effective and innovative process equipment is critical for continuously maintaining the sustainability of these technologies. He appreciated the efforts taken by C-MET in this direction and in ensuring supply of some of the important high purity metals and alloys to the country and assured the support of DRDO to C-MET in all its future endeavors.

Address by Guest of Honour: Prof. B S Murty, Director,Indian Institute of Technology, Hyderabad

Prof. B S Murty, Director, IIT Hyderabad addressed the distinguished scientific community gathered for the event. He appreciated C-MET for developing viable technologies on e-waste recycling and extraction of precious metals from PCBs. He further said that IIT Hyderabad and C-MET Hyderabad are jointly going to conduct M.Tech program on e-waste recycling from this academic year onwards for creating qualified human resources and making them to entrepreneurship on e-waste recycling. He appreciated C-MET for achieving self-reliance in Hafnium technology for India's space requirements. He expressed his desire that India should march forward with futuristic and commercially viable technologies ahead of global competitors.

Release of souvenir

ICPREM-2020 conference souvenir was released by dignitaries on the dais.

Handing over of 7N pure Germanium to SSPL, DRDO

C-MET Hyderabad laboratory successfully executed a DRDO sponsored project and developed the process technology for recycling of scrap Germanium to ultra high pure Germanium by indigenously designed and fabricated induction zone refining system. During the inaugural session of ICPREM-2020, Dr. Y. Purushotham, Principal Investigator of the project handed over 1 kg of 7N pure Germanium to Dr. Anant Naik, Director, GAETECH on behalf of SSPL, DRDO.

Presidential address by Shri Ajay Sawhney IAS, Secretary, Ministry of Electronics and Information Technology (MeitY) Govt. of India (through video conferencing)

Honourable Secretary, Ministry of Electronics and Information Technology (MeitY), Govt. of India, Shri Ajay Sawhney, IAS has participated through video conference due to the ongoing parliamentary session. He highlighted the importance of recycling electronic materials and recovery of precious metals through scientific green and safe process. He mentioned about the environmental issues created by unorganized sectors in recovering the metals from e-waste. In this connection, he called for concerted efforts by all scientists/technologists throughout the world in coming out with viable solutions on this issue. He appreciated the efforts of C-MET in this area and emphasized that this vital technology should benefit the society at large. Emphasized on critical technologies developed by C-MET in ultra high purification of metals for semiconductor applications, compound semiconductors and their characterization. He congratulated C-MET for organizing an International Conference on Purification and Recycling of Electronic Materials (ICPREM-2020) in conjunction with its 29th foundation day celebrations.

Achievements of C-MET in a cursory glance - Dr. N. R. Munirathnam, Director General, C-MET

Dr. N. R. Munirathnam Director General, C-MET gave a concise presentation on the recent achievements of C-MET. He expressed his gratitude to the global gathering of ICPREM-2020 including pioneered Scientists, Academicians, Engineers, Entrepreneurs and Students working in the niche R & D areas.

Dr. Munirathnam highlighted recent developments on eco-friendly electronic waste recycling to extract precious metals such as palladium, gold, silver, copper etc.; ultra high pure (>99.99999 at.%) metals namely germanium, zinc, cadmium, tellurium for detector applications; hafnium metal sponge (only source in India) used in making strategically important high temperature alloys, high neutron cross-section nuclear reaction controlling rods and modern electronic devices; wide band gap (>3eV) silicon carbide single crystals used in high frequency and high temperature electronics devices used in the area of communication; microwave substrate for high frequency and high power (750W) applications, carbon aerogel as well as graphene based super capacitor for energy storage and hybrid batteries, wearable electronic devices for early breast cancer detection; electro-ceramic actuator; LTCC packaging for variety of electronic devices and many more interesting R&D areas in C-MET laboratories located at Pune, Hyderabad and Thrissur.

Dr. Munirathnam mentioned that India is the fifth largest producer of e-waste after countries such as US, Japan, China and Germany. E-waste produced in the world is around 50 million tonnes and in India, it is 6.5 million tonnes. He emphasized the need for creating an environment friendly business model for the recovery of precious metals so that circular economy and sustainability are ensured. He mentioned that C-MET has developed 100 kg process for recovery of precious metals from PCB and also 1 ton facility was created at industrial collaborator place at Bangalore through MeitY sponsored project. On this occasion, Dr. Munirathnam announced that a state of the art Centre of Excellence on E-Waste Management is being established at C-MET, Hyderabad to provide one stop recycling solutions to Indian industries. This project is funded jointly by the Ministry of Electronics and Information Technology and Govt of Telangana.

Foundation Day Lecture

Foundation day lecture by Prof. Animesh Jha, University of Leeds, UK

Title:- ***Extraction of rare-earth oxides from titaniferous and monazite concentrates and their importance in the energy devices and systems***

Prof. Animesh Jha delivered an exciting lecture on extraction of rare-earth oxides from titaniferous and monazite concentrates. He explained in detail about linear versus circular economy of materials consumption and technology vision for rare-earth oxides and applications. The physical chemistry of rare-earth oxides separation from ilmenite and monazite are explained. The role of different alkali on the decomposition characteristics of ilmenite, monazite and changes in the morphologies of reaction product are explained. Prof. Jha also explained about the separation of Nd_2O_3 and Pr_2O_3 from the mixture of rare-earth oxides in colloid forms for magnetic materials manufacturing. CeO_2 and La_2O_3 were separated for catalytic converters and fuel cell applications. The importance of chlorination reaction for effective physio-chemical separation using high and low temperature electro-chemistry using molten salt and ionic liquids was also discussed.

Prof. Animesh Jha also addressed the impact of strategic materials and mentioned that it is critical in defining the renewable landscape of a country like India, which has large potential for benefiting from such resources.

Invited Lectures

Prof. Marlia Mohd Hanafiah, University of Kebangsaan Malaysia, Malaysia

Title:- ***Life Cycle Thinking for Sustainable E-Waste Management***

Prof. Marlia Mohd Hanafiah made an elaborative presentation on the rapid economic growth, technological advancement in electrical and electronic industry and innovative products for the increasing consumption of electrical and electronic equipment. Due to increasing trends in the consumption globally, managing end-of-life (EoL) electrical and electronic equipment has become important. Prof. Marlia mentioned that uncertainties existing regarding EoL impact on the human health and environment. Therefore, it is crucial to establish a full understanding of the environmental benefits and burdens of E-waste materials over its full life cycles and to explore recent developments, progress and challenges of life cycle assessment application in E-waste management.

Dr. Sandip Chatterjee, Scientist F and Director, Ministry of Electronics and Information Technology, Govt of India

Title:- ***Sustainable Environment Friendly Electronics Waste Recycling***

Dr.Sandip Chetterjee has delivered an informative and thought provoking lecture on E-waste (Management) Rules 2016, which was enacted since October 1, 2016 in India. The rule extended its purview to components or consumables or parts or spares of the electrical and electronic equipment along with their products. Dr. Chatterjee told about MeitY involvement in promoting R&D to develop technological solutions to the e-waste management in an environmental friendly manner. The focus is on finding out cost effective recycling technology leading to minimum landfill and zero emission to air, land and water. The importance of recovery of valuable materials and reuse of plastics to make recycling, economically profitable business was also deliberated.

Dr. R. Radhakrishnan Sumathi, Leibniz-Institute for Crystal Growth (IKZ), Berlin, Germany

Title:- ***End to End Process and Technology Development for Ultra High Pure Germanium Crystalline Materials***

Dr. R. Radhakrishnan Sumathi delivered a scintillating lecture on end to end process and technology development for ultra high pure Germanium crystalline materials. She talked about Germanium, applications and its consumption. According to German Mineral Resources Agency, by 2030, the demand for Ge will grow considerably due to dramatic increase of fiber optics market and advanced materials sector. Dr. Sumathi presented about the challenges in establishing an end to end ultra high pure Ge crystalline material development. Source materials reduction to reach a purity level of 6N which is a starting material for induction zone refining to get 12N purity followed by high purity crystal growth of >2 inches diameter by Czochralski technique. Quality and purity of the grown crystals verified by PTIS and ICPOES techniques.

Prof. E.B.Yakimov, Russian Academy of Sciences, Chernogolovka, Russia

Title:- ***EBIC and DLTS characterization of semiconductor materials***

Prof. E.B.Yakimov delivered an interesting lecture on EBIC and DLTS characterization of semiconductor materials. Prof Yakimov informed that with decreasing dimensions and increasing complexity of highly integrated circuits the tolerable concentrations of detrimental impurities have to shrink considerably. Deep Level Transient Spectroscopy (DLTS) method which provides comparable sensitivity in low-doped crystals. New electronic materials such as GaN and Ga_2O_3 contain much higher defect concentration than Si. Prof. Yakimov explained about indirect methods for evaluation of small defect concentrations in silicon with gold diffusion and plastic deformation. Dislocations are rather effective impurity getters. As a result their recombination properties can be changed that can be studied by Electron Beam Induced Current (EBIC) method.

Dr. P. Pathasarathy, Managing Director, E-Parisaraa Pvt Ltd, Bengaluru, India

Title:- ***Recycling of precious metals from electronic industries***

Dr. P. Parthasarathy delivered a scintillating lecture on Recovery of precious metals from spent EEE products. End of life electronics contain significant amounts of precious metals such as Gold, Silver, Palladium which need to be recycled in a scientific manner to promote the resource recovery. During manufacture of electronic materials, the actual precious metals used in the above components are much less than what is actually consumed. Therefore, the precious metals consumed during processing need to be recovered to improve the economy of the process and proper accounting. Dr. Parthasarathy presented an overview of recovery and purification methods of precious metals used in various recycling industries.

Dr. Uttam Doraswami, Director, Elxion Pvt Ltd, Bengaluru, India

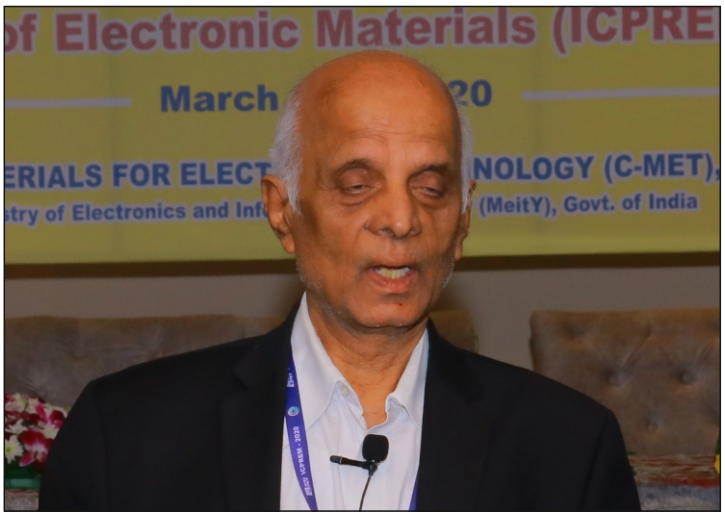
Title:- ***Modular solutions metal recovery from PCB scrap***

Dr. Uttam Doraswami has delivered an informative and thought provoking lecture on modular solutions for metal recovery from PCB scrap. He told that the biggest gap in the development and commercialization of formal, environmentally sustainable recovery solutions in India is the availability of suitable, legal, cost-effective, scalable process for metal recovery from waste electrical and electronic equipment (WEEE) printed circuit board scrap. This is why the informal sector and backyard refiners continue to thrive. Dr. Doraswami presented novel multi-metal leaching experiments followed by selective electrochemical recovery of high surface area electrodes which is a safe, cost-effective and clean technique for the recovery of Au, Ag, Pd, Cu, Sn and Pb from shredded PCB scrap. He also presented modularized solutions and results on recovery rates and OPEX estimates.

Dr. B. K. Gorain, Chief Technology & Innovation Officer, Hindusthan Zinc Ltd, Udaipur, India
Dr. V. I. Lakshmanan, CEO and Vice Chairman, Process Research Ortech, Ontario, Canada

Title:- ***Recovery of minor and strategic metals from base metals waste stream***

Dr. B. K. Gorain and Dr. V. I. Lakshmanan delivered highly motivational lecture on recovery of minor and strategic metals from base metals waste streams. Recovery of minor metals from various base metals waste streams become a major focus for many mining companies across the world, said the speakers. The demand for minor metals such as germanium, indium, gallium, cobalt and many others increased significantly because of the emergence of many strategic applications due to technological advancements. A multi-disciplined approach is of utmost importance in this partnership. Ore characterization, geo-metallurgy, quantification of the losses in waste streams, process mineralogy, innovative communication, concentration, leaching & solvent extraction along with various environmental, sustainability, engineering and economic considerations are critical for developing robust solutions to minor metals recovery problems.



Dr. Debaraj Mishra, Sungeel India Recycling Pvt Ltd., Hindupur, AP, India

Title:- ***Opportunities, Challenges & Trends in Lithium Ion Battery Recycling in India***

Dr. Debaraj Mishra delivered an interesting talk on opportunities, challenges & trends in Lithium ion battery recycling in India. He told that there is a serious lack of regulations addressing end-of-life lithium ion batteries regarding collection and recycling to recover resources. There is regular generation of such waste into the society and our entrepreneurs are missing the chance to utilize the resources due to lack of proper guidelines for collection, storing, transportation and cost of recycling. The need for regulations is crucial in order to formally manage the spent lithium ion batteries in India. Since there is strict regulation to export such types of waste it is high time for us to regulate and recover the resources in the country to circulate the economy.

Shri K. V. Mirji, General Manager, Nuclear Fuel Complex, Hyderabad, India

Title:- ***Vital aspects in purification of refractory metals and characterization of high purity materials***

Shri K.V.Mirji delivered a motivational lecture on purification of refractory metals and characterization of high purity materials. Shri Mirji mentioned that increased demand for high purity refractory & reactive metals and their alloys in the field of advanced technological applications has led to the development of special purification processes. Combination of chemical and physical techniques are essential to achieve this goal of producing high purity materials. Refractory metals and their alloys can be purified from gaseous impurities and volatile elements to very low levels by electron beam refining method only. He explained details of processes developed at NFC for production of varieties of high purity materials covering specific achievements and practical aspects in production and characterization.

Prof. K.A. Bulbule, Consultant, E-Parisaraa Pvt Ltd, Bengaluru, India

Title:- ***Eco and environmental benefits of recovery of metals from printed circuit boards over traditional metallurgical process with particular reference to Al, Cu, Ag and Au***

Prof. K. A. Bulbule has delivered an interesting lecture on eco and environmental benefits of recovery of metals from PCBs over traditional metallurgical process with reference to – Al, Cu, Ag and Au. He said that India is the fifth largest e-waste producer in the world. Urban mining is the process of recovering metals from e-waste PCBs in an environment friendly method. He also mentioned that MeitY took a bold step of recovering these metals by urban mining and a collaborative research carried out jointly by C-MET Hyderabad and E-Parisaraa Pvt Ltd, Bengaluru has resulted low cost, eco and environment friendly technology of recovering metals like copper, silver and gold. Pyro metallurgy is carried out using indigenously designed and fabricated smelter coupled with gas cleaning system followed by electro refining and processing of anode slime. Urban mining is highly beneficial over traditional mining. Prof. Bulbule also presented other eco and environmental benefits of urban mining for recovery of aluminium, copper, silver and gold from PCBs over the traditional mining practiced over centuries.

Panel Discussion, Poster session and Best Poster Awards

Dr. N.R. Munirathnam, Director General, C-MET and Chairman, ICPREM-2020 chaired the concluding session with words of appreciation to all invited speakers for delivering inspiring lectures that made ICPREM-2020 a grand success on the occasion of Annual foundation day of C-MET. Prof. E. B. Yakimov, Prof. K. A. Bulbule, Prof. M. Vithal, Dr. N. Raghu, Dr. R. Prasada Rao and Dr. R. Ratheesh participated in the panel discussion.

A dedicated poster session was conducted and a technical committee evaluated all posters. Three best poster awards were announced by Dr. N. R. Munirathnam with certificate and prize money of Rupees 3000, 2000 and 1000 to first, second and third position, respectively.

1st prize

2nd prize

3rd prize

Following recommendations were made during ICPREM-2020 conference for submission to the Government

- Government can come out with policy that ensures end of life (EoL) electronic gadgets goes back to the manufacturers and then it is routed to organized sectors

OR

- Authorized agents for collecting EoL gadgets in specified regions shall be notified, so that gadgets are collected by them and send to organized sectors
- The above should not affect the livelihood of persons engaged in unorganized sector
- With government financial support, the unorganized sector needs to be made aware of environment, health and safety (EHS) norms and has to be trained by organized sector
- The processes technologies developed should be low cost and environmental friendly
- Apart from central government, state government should also involve and establish more number of pilot scale set ups for recovery of metals
- The present unorganized sector should get the access to these clusters and to get their jobs done on a reasonable cost
- Representatives from government, R&D institutions, organized sectors and that of unorganized sectors shall be brought together and made aware of the draft policies so that all stake holders become part of management
- Each pilot level plant shall be within 10 kms radius accessible to both organized and unorganized sectors thereby bringing the unorganized to organized
- After completion of awareness, training programs and infrastructure creation across the country should be initiated.
- Processing of e-waste through unscientific methodology should be banned by the government and made it as non-bailable punishable offence, if violated.

Visit to C-MET Hyderabad Laboratory

On the last day of the conference, invited speakers and participants visited C-MET Hyderabad laboratory. Dr. N. R. Munirathnam, Director general, C-MET and Chairman, ICPREM-2020 welcomed all the delegates and deliberated about the R&D activities being pursued at C-MET. Dr. R. Ratheesh, Director, C-MET, Hyderabad and co-Chairman, ICPREM-2020 gave a detailed presentation about laboratory activities. After that visitors were taken to processing plants, senior scientists explained about the ongoing activities such as E-waste dismantling, segregation, depopulation and recycling etc. were explained with live demonstrations. Participants gave excellent feedback and thanked the organizers for providing a good opportunity to visit different plants. Dr. E.B. Yakimov, Professor, Russian Academy of Sciences (RAS) Chernogolovka, Russia working on Deep Level Transient Spectroscopy (DLTS) visited SiC single crystal facility and had detailed discussions on characterization of ppb level impurity analysis in SiC single crystals using DLTS. Dr. Uttam Doraswami, Director, Elxian Private Limited, Bengaluru expressed willingness to collaborate with C-MET Centre of Excellence on E-waste Management on the extraction of precious metals through hydrometallurgical routes.

Overall, the outcome of the International Conference is very propitious which will provide impetus for the on-going R&D activities and pave way for addressing challenges in the future endeavours.


E-WASTE PLANT