**REPORT ON THE NATIONAL CONFERENCE ON CRITICAL AND STRATEGIC MATERIALS FOR ADVANCED TECHNOLOGIES 2017 (CSMAT- 2017)**

The National Conference on Critical and Strategic Materials for Advanced Technologies 2017 (CSMAT- 2017) was organized by the Rare Earths Association of India in association with the Indian Society of Analytical Scientists (ISAS) Kerala Chapter at Hotel Tea County, Munnar, Kerala during March 09-11, 2017. .This Conference was conceptualized based on the demand for a platform where leading scientists, technologists, academicians, researchers, business leaders, policy makers and other stakeholders would be able to interact, exchange ideas and communicate with each other on all aspects of the emerging areas of critical and strategic materials, discuss the present state of the art in their applications in advanced technologies, and also suggested future directions. The conference covered almost all the areas of critical and strategic materials and painted a broad canvas dreamed about future capabilities for innovations in this field. Around 100 research papers have been received from academia and industry. The present conference provided adequate scientific and social environment for scientists and technologists to discuss new developments in the field of critical and strategic materials, share experiences and results with experts. CSMAT - 2017 conference held at Munnar was the latest in the series of several conferences organized by REAI to promote science, technology and applications of critical materials in India.

**Inaugural Session**

Shri N.A.Baldota, Maanaging Director, MSPL Limited *inaugurated* the Conference. In his inaugural speech Shri Baldota talked about the importance of critical and strategic materials in the growth and prosperity of our country. In his inaugural speech he stressed the importance of Energy which has played an important and inseparable role in human survival and civilization. Today, with the fast economic growth in a highly populated country such as India our thirst for energy has increased manifold. Energy is becoming a top priority in our standard of living, prosperity, and even national security. Energy demand increase is fueled by population increase; part of it is fueled by the desire to improve living standards and expand economic growth. Critical and strategic materials and energy production have a continual and mutually enriching relationship .In the complex web of energy resource, production, storage, use, and efficiency, several materials play a critical role as diverse and far-reaching as energy itself. Critical materials enable the production of energy or the transformation of primary energy into useful forms. Energy, in turn, has made possible the production of a broad range of materials for the society: from liquid-state fluids, to solid-state devices, and to high-temperature components. Materials for energy come in a near continuum: naturally occurring materials releasing energy through chemical or nuclear reactions, refractory metals and ceramics used in energy conversion systems, and functional materials for energy storage and use. Increasing demand for energy, diminishing stocks of fossil fuels, and the public’s desire to enhance environmental quality, particularly by reducing greenhouse gas emissions, are areas where critical and strategic materials are required. All these point to the need for improved materials. For producing green energy materials with improved performance novel capabilities are required In this context the three day conference will be very important. He hoped that this conference will go a long way in promoting R&D in the field of critical and strategic materials needed for advanced technologies and provide our country materials with fascinating properties that give us the high hope of tackling the challenging energy problems faced by our country.

A souvenir brought out in commemoration of the conference was released by the guest of honour, Shri Devendra Singh, CMD Of Indian Rare Earths Limited. He gave a brief talk in which he stressed the importance of rare earths in the field of green energy and importance of rare earth industry for the development of India In the inaugural session REAI life time achievement award for 2016 was presented to Dr T.K.Mukherjee, former CMD, IREL and Distinguished Scientist Bhabha Atomic Research Center, Mumbai, in recognition of a lifetime of distinguished achievements and outstanding contributions made by him for the advancement of extraction metallurgy .The award, waspresented to Dr. Mukhejee by Dr. Ayyappan Pillai Ajayaghosh*, Director,* National Institute for InterdisciplinaryScience & Technology, Council of Scientific and IndustrialResearch (CSIR), Thiruvananthapuram 695 019, Kerala State. In his talk, Dr. Ajayaghosh congratulated REAI and ISASK for organizing the conference on such an important topic relevant to the energy and science scenario of our country..

Dr. R.N.Patra, President-REAI and former CMD-IREL presided over the inaugural function. Chairman of the organizing Committee, Dr M.L.P.Reddy, welcomed the gathering. Shri S.Sudarsan Kumar, Convener of the Organizing Committee proposed the vote of thanks. Dr. T.K.Mukherjee the REAI life time achievement award winner 2016 spoke on the occasion. He thanked the organizers for electing him for the award and promised that he will continue to carry out outstanding research in the field of extraction metallurgy.

The inaugural session was followed by technical session I. Dr P.P.Chandrachoodan, Member, Kerala State Innovation Council chaired the first technical session. Dr.T.K.Mukherjee, the winner of REAI life time award 2016 presented his award talk in this session. The title of his talk was ‘Recovery of scandium oxide as byproduct from indian ilmenite during its proposed commercial scale processing to TiO2 pigment by sulphate route”. In his presentation, an effort has been made to highlight the various aspects of scandium recovery in our country for the first time with interesting possibilities. Solvent extraction process for the recovery of scandium from spent sulphuric acid obtained during sulfuric acid processing of ilmenite was discussed by Dr. Mukherjee. Dr. G.Sundararajan, Former director of ARCI, Hyderabad in his plenary talk entitled, “ Rare earth elements scenario in India and their applications”, focused on the rare earth metals scenario in India covering resources, research and prospective technologies that could emerge out from Rare earth elements. A brief mention on recovery and recycling processes of the rare earth elements will also be touched upon during the discussion. He also covered lithium scenario in India during his talk. The first invited talk of the conference entitled,” Multicomponent equiatomic rare earth oxides – new materials with unexplored potential”, was presented by Prof.Horst Hahn,visiting scientist, ARCI, Chennai. His studies revealed unexpected drastic lowering of the band gap compared to the binary (undoped and doped) rare earth oxides thus enabling light absorption in visible range, which is of high interest for the field of photocatalysis and photovoltaics. He presented the results of his studies in the talk.

.Technical session II was chaired by Dr. P.N. Mohandas, former deputy director, NIIST, Thiruvananthapuram.

Four invited talks were presented in this session. The first talk was delivered by Dr. R.Gopalan, ARCI, Chennai. The title of his talk was “Penetration of rare earth permanent magnets into all fields of application.

REPMs are the key players of many electromechanical and electronic devices in modern technology especially in automotive and aerospace sectors. Revolutionary developments have recently occurred in the field of permanent magnetism. Hard ferrites became an abundant inexpensive magnet material while the rare-earth magnets raised the highest available energy products 4 to 5-fold and coercivity by an order of magnitude. As a consequence, a rapid broadening of magnet uses is now occurring; traditional devices are miniaturized, new applications and design concepts are evolving. Trends and examples were discussed in this presentation. An assessment of currently evolving permanent magnet materials. Production processes, prospects for new, still “better” magnets, as well as ultimate upper limits for permanent magnet properties were also discussed. S. K. Bhushan, Ramgad Minerals and Mining Limited, Baldota Enclave, Abheraj Baldota Road, Hospet – 583 203 presented the next invited paper. The title of the talk was ” Exploration and feasibility study of Kamthai rare earth deposit, Barmer district, Rajasthan. According to him,” a wide spectrum of calcio-carbonatites and associated alkaline rocks are exposed around Kamthai, Barmer District, Rajasthan. The mineralogical studies exhibit a bimodal distribution of REE minerals. In his presentation he described the steps required to exploit the deposits commercially. The next paper was presented by A.K. Chaturvedi, Director, Atomic Minerals Directorate for Exploration and Research, Hyderabad-500016. The title of his talk was “Geological setting and resources of the major rare-earth-elements deposits in India”. Extensive exploration activity by AMD in major alkaline carbonatite complex of India has led to establishment of sizeable reserve of REE in Ambadongar Carbonatite (Gujarat), Siwana Ring Alkaline Complex (Rajasthan) and Pakkanaducarbonatite (Tamil Nadu).Potentially one of the most favored geological settings for high grade, large tonnage polymetallic REE deposits are carbonatites and alkaline igneous complexes, which occur along distinct shear and fault zones in India. Advance exploration techniques need to be applied for detailed prospecting of REE minerals in the alkaline igneous source rocks, which include high resolution airborne and surface gamma-ray spectrometric (to detect Th and U contents), magnetic (presence of magnetite), gravity surveys and heavy-mineral studies. The last paper in this session was presented by Shri C.Swamydas, Chief consultant, VV Mineral. The title of his talk was “Titanium and Rare Earths in India- dream yet to be realized”. All the BSM based products are very much sought after commodities now as they find wide utilization in everyday life. Technological development is moving on a very fast pace and whatever material is important today may not be required after a few years, as substitute materials are being developed.. The titanium, zirconium and rare earths, which are important materials now may not be relevant after fifty to hundred years. Hence it becomes necessary for India to step up the exploitation of the BSM mining to reach the international PRR of 0.01, as otherwise India will miss the chance and the BSM deposits may be buried under the earth forever.

Technical session III was presented by Dr.R.S.Jayasree Senior Scientist from Sri Chitra Tirunal Institute for Medical Science and Technology, Thiruvananthapuram. In this session nine contributed talks- short presentations were delivered.

On 10/03/2017 Technical Session IV was started at 09.46 A.M. Prof. M.R.Anantharaman from Department of Physics, Cochin University of Science and Technology was the chairman. The first talk in this session was delivered by Dr Mridula Bharadwaj from Centre for Study of Science, Technology and Policy, Bangalore-560094. The title of her talk was”Indian rare earth industry: current status and future opportunities”. According to her in case of REE the key issue is the separation of the individual elements. State of the art rare earth metals extraction techniques and facilities have to be pooled and the gap in the areas needs to be identified. Recycling of end-of-life rare earth containing products are another source of critical rare earths and these technologies need to be developed on commercial scale. As large scale adoption of clean technology is expected in future, it is important to achieve self-sufficiency in rare earths value chain. India needs to take necessary initiatives in value added refining, metal/alloy production and manufacturing components for end-use. The issues surrounding the REEs need serious and sustained attention and we need a national level programme to develop a robust REE sector roadmap. The next talk was presented by Dr. Ranga Rao from IIT, Chennai.The title of his talk was Rare earth oxide materials for thermochemical H2O and CO2 splitting. Ceria is an important material for thermochemical splitting of water and carbon dioxide.Nanoscale ceria with different morphologies and high surface area would be extremely useful but difficult to sustain at high temperature operations. This was followed by the talk of Prof.S.Natarajan from Indin Institute of Science, Bangalore. He talked on New Inorganic pigments. In his talk he addressed some of the issues and efforts made by him and his team towards identifying new chromophores employing transition metal chemistry .

Technical session V was chaired by Prof.S. Srinivasan from IISc., Bangalore.The first paper in this session was presented by Dr S.K.Sahu from National Metalurgical Laboratory, Jamshedpur. He talked on Sustainable process development for the recovery of rare earths from waste phosphor powders of fluorescent lamps. At CSIR-NML a complete hydrometallurgical process to recover high pure yttrium and europium oxide including individual oxides of cerium, lanthanum and terbium from waste phosphor powders has been developed. The salient features of the process developed at CSIR-NML were elaborated in detail by him in his presentation. The next invited talk was presented by Dr H.K.Bhat from NIIST, Thiruvananthapuram. The title of his presentation was “ Upgradation of low grade ilmenites as suitable titanium feed stocks - an effort towards resource sustainability through environmentally benign technologies.” His presentation highlighted the details of the various process parameters employed at each stage of beneficiation of ilmenite. Investigations on mini pilot plant scale for the production of beneficiated ilmenite for evaluation and customer feedback were also discussed. Efforts on the plant scale demonstration of the process flow sheet making use of commercial DRI rotary kiln and industrial reactors was also discussed in the presentation. The last paper in Session V was presented by Dr. D.Mandal from Bhabha Atomic Research Centre, Mumbai. The world consumption of lithium is increasing day by day. In the early 1900s its consumption was less than 100 Ton (in lithium carbonate equivalent) per annum whereas it has increased to more than 70,000 Ton per annum in 2000. Dr. Mandal gave a very informative talk on Technologies for the extraction of lithium.

Technical session VI was chaired by Dr. N.K.Pillai, CEO, Kerala Enviro infrastructure Limited, Cochin. Prof.M.R. Anantharaman from Dept. of Physics, Cochin University of science and technology delivered the first talk in this session. The title of his talk was on “the development of porous 3d structures based on

2d graphene and hexagonal boron nitride for applications. This talk focused on the synthesis of GO and functionalized GO, h-BN. 3D solids based on 2D structures which were made and tested for useful applications. Some of the applications include CO2 capture, microwave absorption and nanofluids for effective thermal management. Various details were discussed in the talk. The next talk was presented by R.Vijayalakshmi from Bhabha Atomic Research Center, Mumbai. The title of her talk was ”Advances in the hydrometallurgical separation techniques of high purity rare earth elements. She discussed the recent advances made in hydrometallurgical separation techniques based on solvent extraction technique, ion-exchange resins, hollow fibre membrane extractor, solvent encapsulated polymeric beads, etc. for the production of high purity rare earth elements from both primary (Monazite, xenotime) and secondary sources (phosphoric acid, fly ash, end-of-life products) while focusing on challenges faced in developing the processes for separation of heavy rare earth elements at BARC. Dr. A.P.Jayaraman from Indian Institute of Materials Management, Mumbai presented the last paper in this session. He gave an interesting and informative talk on Supply chain vulnerabilities and strategic global sourcing management of critical elements. This was followed by poster session in which 62 posters were presented. Dr. P.N.Mohandas and Dr Daisy Joseph evaluated the posters. The wealth of material covered in the poster sessions was remarkable. Among many significant contributions, six presentations were selected for the best poster awards.

On March 11th the Technical Session started at 09.45 AM, This was Technical Session VII chaired by Dr. H.K.Bhat from NIIST, Thiruvananthapuram. The first talk in Session VII was presented by Dr. T..Srinivas, Materials Group, Bhabha Atomic Research Centre (BARC), Mumbai 400085, Mineral Processing Division, BARC, Hyderabad 500016. The title of his talk was “ Valorization of mine rejects and industrial wastes for the recovery of some strategic and critical metals”. In this paper representative case studies which depict technical feasibility of using industrial waste as a source for some important SCM, namely Nd, Y, Co and W were presented. The wastes used for valorization are the mine tailings or rejects of different ores like copper, gold, uranium and fly ash generated from a coal-fired thermal power plant was also covered by him in his talk. Dr. D.K.Singh from Bhabha Atomic Research C enter, Mumbai presented the next talk on “Recovery of uranium from secondary sources.” .In his talk he presented hydrometallurgical processes employed for the recovery of uranium from secondary sources such as phosphoric acid

“ Liquid crystalline materials - the fascinating state of matter in our life” was the title of the next talk presented by Dr. Sudha J. Devaki, Chemical science and Technology Division CSIR-NIIST, Trivandrum.

The last invited talk of the conference was delivered by Dr. Amrit Prakash of Bhabha Atomic Research Center, Mumbai. The title of his talk was ” Analytical methodologies in chemical characterization of nuclear materials”. Analytical chemistry plays a very important role in the chemical characterization of nuclear materials. Nuclear Materials include fuel, clad materials, coolant, moderator, shielding materials etc. India is among the few countries that has mastered the entire fuel cycle including processing of uranium, zirconium, thorium etc.He described important analytical techniques used for characterization of nuclear materials at BARC.

The last Technical session of the conference was chaired by Prof. C.K.Jayasankar from SV University, Tirupati. In this session seven contributed papers –Oral were presented. Dr. P.N.Mohandas and Dr. Daisy Joseph evaluated the short oral presentations.

Awards were presented to the presenting authors during the concluding session.

The concluding session was chaired by Dr. P.P.Chandrachoodan, Member, Kerala State Innovation Council, Thiruvananthapuram. Dr Chandrachoodan spoke on the importance of scientific conferences such as CSMAT 2017 in promoting awareness among scientists, technologists and particularly students about the latest developments in Science and Technology. The present conference will play a significant role in the development of critical and strategic materials and their applications. He urged the organizers to continue organizing similar conferences periodically. He shared experiences gained by him during his participation in several conferences with the participants and urged them to work hard to spread the developments gained in the field of science and technology to take India to greater heights. Dr. M.L.P.Reddy, Dr. P.N.Mohandas, Dr. Daisy Joseph, Prof. C.K.Jayasankar, spoke on the occasion. There was a feedback session in which the participants voiced their opinions and comments. All those who attended the conferences agreed that the event was a grand success. There was record attendance at the technical ses­sions, and the sessions covered a wide range of topics in processing and applications of critical as well as strategic materials. Awards were presented to the best poster and oral presentations. List of award winning posters and oral presentations are given below:-

Best Posters

1. INVESTIGATION ON THE EFFECT OF Ti DOPING ON THE Sn SITE OF Na1.1Ca0. 8Eu0.1SnNbO6 : NOVEL PEROVSKITE RED PHOSPHOR PREPARED BY BALL MILLING METHOD FOR WLED APPLICATION

Aswathy B. A and P. Prabhakar Rao

Materials Science and Technology Division,CSIR- National Institute for Interdisciplinary Science and Technology (NIIST),Thiruvananthapuram, India

2. FLUORESCENCE IMAGING OF LYSOSOMAL ZN(II) ION AND THE APOPTOSIS STUDY IN CANCER CELLS USING AN AGGREGATION BASED PROBE

K. V. Sudheesh and A. Ajayaghosh∗

Chemical Sciences and Technology Division and Academy of Scientific and Innovative Research (AcSIR),CSIR-National Institute for Interdisciplinary Science and Technology (CSIR-NIIST), Trivandrum-695019, *India*

3CONCENTRATION DEPENDENT LUMINESCENCE PROPERTIES OF Nd3+-DOPED BISMUTH-BORATE GLASSES

K. Udaya Kumar, G. Venkataiah, V. Rajeswara Rao, C. K. Jayasankar

Department of Physics, Sri Venkateswara *University,* Tirupati-517 502, India.

4. EXTRACT-MEDIATED FABRICATION AND CHARACTERIZATION OF SILVER NANO CRYSTALS INITIATED FROM A. INDICA LEAVES FOR ANTICORROSIVE COATINGS

Ulaeto, Sarah B.,a,b,c Jerin K. Pancrecious,a,b Ramya Rajan,a  T.P.D. Rajan, a,b and B. C. Pai

a Material Science and Technology Division, CSIR-NIIST, Trivandrum, Kerala, India,

bAcademy of Scientific and Innovative Research (AcSIR), New Delhi

cDepartment of Chemical Sciences, Rhema University, Aba, Abia State, Nigeri

5. RECLAIMING RARE EARTH ELEMENTS FROM WASTE PHOSPHOR POWDERS OF FLUORESCENT LAMPS

Swati Pramanik, M.K. Sinha, Aarti Kumari, S.K. Sahu

Metal Extraction & Forming Division CSIR-National Metallurgical Laboratory, Jamshedpur - 831007, India

Best Oral Presentations

1.STUDY OF STRUCTURAL AND PHOTOLUMINESCENCE PROPERTIES OF Bi3+ DOPED La3TaO7 PHOSPHOR

Suchithra V.G and P. Prabhakar Rao

National Institute of Interdisciplinary Science and Technology,CSIR, Trivandrum-695019, India

2.STUDIES ON WEAR AND CORROSION CHARACTERISTICS OF ELECTROLESS Ni-B-CeO2 NANOCOMPOSITE COATINGS ON A356 ALLOY

Jerin K. Pancrecious, Sarah.B. Ulaeto, R. Ramya, T.P.D. Rajan, E. Bhoje Gowd and B.C. Pai

Materials Science and Technology Division CSIR - National Institute for Interdisciplinary Science and Technology Trivandrum – 695019, Kerala

3 . A LYSOSOME TARGETABLE LUMINESCENT BIOPROBE BASED ON A EUROPIUM B-DIKETONATE COMPLEX FOR CELLULAR IMAGING APPLICATIONS

T. M. Georgea, Mahesh S. Krishnab and M. L. P. Reddy \*a

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bCardiovascular Diseases and Diabetes Biology Lab, Rajiv Gandhi Centre for Biotechnology, Thiruvananthapuram, India

4. A HIGHLY SELECTIVE CHEMOSENSOR FOR CYANIDE DERIVED FROM A FORMYL FUNCTIONALIZED PHOSPHORESCENT IRIDIUM(III) COMPLEX

K. S. Bejoymohandas and M. L. P. Reddy\*

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Overall, CSMAT 2017 was a lively interdisciplinary conference where research and development efforts and emerging issues in the area of critical and strategic materials for advanced technologies were thoroughly discussed in an enjoyable atmosphere. The conference was well organized and managed throughout, and prompted optimum interaction between the delegates and experts. This was an interdisciplinary conference and has the advantage of the cross-fertilization that occurs when people dealing with various aspects of chemistry, physics, biology, technology and engineering come together and discuss diverse ways of looking at similar problems. The diversity and depth of presentations were truly impressive has prompted the organizers to continue organizing similar conferences periodically. It was decided that further steps should be taken to create awareness among the scientific fraternity, technologists and students about the availability of : (a) critical materials that can revolutionize science and technology, (b) novel technologies that can create, process and produce smart materials and (c) characterization techniques that can diagnose novel advanced materials which can promote R&D in our country.