Dr. ABHILASH ***M.Sc., Ph.D., FSABT, MNASc***

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**mobile +91-9431962767** Image result for skype **abhilashnml**

**mail Scientist, Secondaries and Resource Recycling Group,**

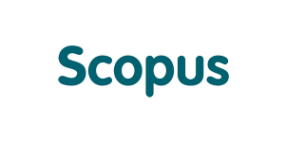
**Metal Extraction & Recycling Division,**

**CSIR-National Metallurgical Laboratory, Jamshedpur, INDIA**

***Assistant Professor, ACSIR-NML, Jamshedpur***

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**images**[**www.nmlindia.org/biometallurgy**](http://www.nmlindia.org/biometallurgy)**,** [**www.abhibios.org**](http://www.abhibios.org)

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**PERSONAL DETAILS**

* **Date of Birth:** 14th Jan 1981
* **Place of Birth:** Jaduguda, Jharkhand (Formerly State of Bihar), India
* **Nationality:** Indian
* **Mother’s Name:** Smt. Sudha Pillai
* **Father’s Name:** Shri. M.R.Shivan Pillai
* **Permanent Address:** “Aswathy”, P.O. Muttom, Via Haripad, Dist: Alleppey, Kerala-690511
* **Current Residence Address:** A-4-44, NML Flats, P.O.Agrico, Jamshedpur, Jharkhand-831007

**OBJECTIVE**

Challenging research scientist position specialized in microbial mineral biotechnology and hydrometallurgy in environmental technology & waste recycling with a high-growth engineering research organization engaged in interdisciplinary process and technological solutions in minerals, metals, materials and environment, with keen interest for expertise build-up and practice long-term research initiatives/collaborations

**PROFESSIONAL OVERVIEW**

* Experience in teaching under-graduate and post-graduate students in microbiology, cell biology, environmental microbiology, genetics and engaging practical labs
* Experience in sophisticated research techniques and technologies: biohydrometallurgy, microbial isolation and characterization, reactor design/operation, bioremediation and waste recycling, process testing and validation, REE extraction
* Organized, take-charge professional with exceptional follow through abilities and detail orientation; able to plan and forth-seeing projects from concept to successful conclusion
* Demonstrated ability to efficiently prioritize a broad range of responsibilities in order to achieve maximum level of operating effectiveness
* Expertise in lab and field research, data collection/analysis and project management, ability to align with cross-functional scientific and research teams

**EDUCATIONAL QUALIFICATIONS**

|  |  |
| --- | --- |
| * Ph.D. (Biochem. Engg)- Biohydrometallurgy of Uranium ores, **Jadavpur University**, INDIA (2012) |  |
| * M.Sc. Biotechnology (Mineral Biotechnology), **Bangalore University**, INDIA (2003), 75.50% |  |
| * B.Sc. Microbiology (with Chemistry), **Nagpur University,** INDIA (2001), 75.33% |  |

**PROFESSIONAL EXPERIENCE (Chronological)**

|  |
| --- |
| * Currently Employed as **Scientist,** CSIR-National Metallurgical Laboratory, Jamshedpur (since 2010) * Serving as **Assistant Professor**, ACSIR-NML, Jamshedpur (since 2013) * Inducted as **Corporate Faculty** at MRD Life Sciences,Lucknow, India (since 2010) * Worked as **Junior Scientist,** CSIR-National Metallurgical Laboratory, Jamshedpur (2007-2010) * Served as **Project Assistant,** CSIR-National Metallurgical Laboratory, Jamshedpur (2005-2007) * Worked as **Lecturer,** SRN ADARSH College, Bangalore University (2004-2005) |

**TEACHING RECORD**

*Subjects Taught with course material preparation (Masters, PhD level)*

* Biohydrometallurgy
* Microbiological methods
* Waste Remediation and Pollution control
* Environmental Microbiology and Biotechnology
* Environmental Chemistry and Biogeochemistry
* Water and Environmental Management
* Waste Recycling and Utilization, and Remediation
* Solid/Hazardous Waste Management
* Extractive Metallurgy of uranium and other strategic metals
* New materials synthesis

*Wet Lab classes with course material preparation (Masters, PhD level)*

* Biomineral Processing
* Water Chemistry
* Biotechnology in Environmental Engineering
* Environmental Technology in Waste Recycling and Utilization
* Nanotechnology for biomaterial synthesis

**COMPETENCY AND RESEARCH INTERESTS**

RESEARCH

* ***Biohydrometallurgy:*** Bioleaching of uranium from low grade indian ores, copper from low grade Indian ores and converter slag, zinc from tailings/ complex/lean ores, metals from ocean deposits, metals from industrial wastes; Biosorption/Bioremediation of heavy metals from effluents, sludges, mine overburdens, acid mine drainage; Bio-beneficiation of chromite, iron ores and slimes, refractory bauxite ores, manganese ores, coal, etc.; Material Biosynthesis of inorganic nanomaterials from wastes; Microbial corossion evaluation
* ***Recycling and Waste Utilisation:*** REE extraction; Battery recycling; WEEE recycling; Allied Aspects of Waste to Wealth/Energy

**EXTRACURRICULAR SKILLS**

**Computer Skills*:*** Web authoring and designing, Operating systems, Business softwares, FACTSAGE, ORIGIN, HSC Chemistry

**Bioinformatics tools:** NCBI, BLAST, MEGA-6

**RESEARCH GRANTS PURSUED**

1. Team Member for “Biomineral Processing for extraction of metal values from ores/concentrates/wastes", Funded by CSIR, New Delhi (2002-2007) (Value: 170,968USD)
2. Team Member for “Treatment/bioremediation of electroplating and leather tanning effluents containing chromium", Funded by CSIR, New Delhi (2002-2007) (Value: 104,133 USD)
3. Principal Investigator for “Microbial leaching of Narwapahar uranium ore :In House Project” (2009-10) (Value: 7,772 USD)
4. Co-Principal Investigator for “Bioleaching of Metals from Sea Nodules in Columns and Air Lift Reactors :In House Project” (2009-10) (Value: 7,772 USD)
5. Activity Leader for “Bioleaching of zinc ores/tailings for synthesis of nanosized Zn-based materials” under Biomaterials Module of Nano-Structured Advanced Materials, Funded by CSIR, NewDelhi (2007-12) (Value: 59,062,797USD)
6. Team Member for “Providing safe drinking water in rural areas using Solar Disinfection technique”, Funded by DST (2007-09) (Value: 57,507 USD)
7. Team Member for “Development of cost effective mine water reclamation technology for providing safe drinking water”, Funded by DST (2007-09) (Value: 97,917 USD)
8. Team Member in “Characterisation of Samples”, Funded by OMML (2009-10) (Value: 4,662 USD)
9. Principal Investigator in “Characterisation of Copper Slag Samples”, Funded by BIRLA COPPER” (2010-11) (Value: 4,662 USD)
10. Co-Principal Investigator in “Evaluating Corrosion of Zn-Ni Coated Steel”, Funded by TATA STEEL” (2010-12) (Value: 96,353 USD)
11. Principal Investigator in “Biochemical beneficiation of iron ore slimes”, Funded by TATA STEEL” (2011-12) (Value: 13,956 USD)
12. Principal Investigator in “Biosynthesis of iron oxide based magnetic nanoparticles from industrial wastes”, Funded by DST-ILTP under Indo-Russian Collaboration (2010-13) (Value: 42,738 USD)
13. Activity Leader in “Biodesulfurisation of High Sulfur Indian Coals”, Funded by Ministry of Steel (2011-14) (Value: 133,650 USD)
14. Principal Investigator in “Processing of spent Lithium Ion battery”, Funded by Renault Nissan R&D, India (2012-13) (Value: 51,284 USD)
15. Principal Investigator in “Chemical and bioremediation of chromite mine effluents”, Funded by TATA STEEL (2014) (Value: 6,620 USD)
16. Team Member in “Development of newer technologies for rare earth extraction from secondary resources”, Funded by CSIR, New Delhi (2012-2017) (Value: 180,250 USD)
17. Principal Investigator in “Hydrometallurgical replenishment of red mud for extraction of rare earth elements”, Funded by NALCO (2015-16) (Value: 13,644 USD)
18. Principal Investigator in “Scale-up trials in Biobeneficiation of Joda Iron ore slimes”, Funded by TATA STEEL (2015-16) (Value: 26,231 USD)
19. Principal Investigator in “Biochemical dephosphorisation of LD slag”, Funded by TATA STEEL (2015-16) (Value: 10,489 USD)
20. Principal Investigator in “Extraction of REE”s from blast furnace slag”, Funded by TATA STEEL (2015-16) (Value: 15,352 USD)
21. Co-Principal Investigator in “Enhancement in process Efficiency in the Production of Ferro-chromium”, Funded by BALASORE ALLOYS LTD. (2016-17) (Value: 10,411 USD)
22. Co-Principal Investigator in “Dephosphorisation of Calcium Ferrite”, Funded by TATA STEEL (2016-17) (Value: 9,324 USD)
23. Member in "Development of Process Flowsheet for Extraction of Tungsten Metal from Hutti Tailings", Funded by DRDO (2016-18) (Value: 264,153 USD)

***R&D PROCESSES DEVELOPED***

* Isolation, characterization and purification of microbial isolates from various sources (22 Industrially important isolates; 13 deposited at NCCS)
* Developed the process for bioleaching of low grade silica-rich and apatite-rich ore of uranium, and tested industrial scale of realization (lab scale to 2ton column scale)
* Developed the know-how for bioleaching of low grade chalcopyrite ore (high recovery with consortia leaching)
* Developed the know-how for Biosorption/bioremediation of tannery effluents (for trivalent chromium source)
* Designed the air-lift bioreactor for large scale bioleaching of sea nodules (using extremophiles)
* Developed microbial based composite for metal remediation from aqueous wastes (product)
* Developed the know-how for bioleaching of zinc tailings and synthesis of Zn based nanomaterials (30-60nm ZnO powders of >99% purity)
* Developed know-how for microbial upgradation of iron ore slimes (from 43% Fe to 58% Fe)
* Developed process for bio-desulphurization of high sulfur coal (total sulfur reduction from 3.5% to <0.5%)
* Developed process for extraction of REEs from red mud (95% REOs) hydrometallurgically
* Developed Process for extraction of REES from blast furnace slag (93% REOs) hydrometallurgically
* Postulated a process for biochemical dephosphorisation of LD slag (reducing from 1.3 to <0.05% P)

***PATENTS (FILED/SUBMITTED)***

**Granted**

1. A process of depositing Zn-Ni-Cu coating on metal products to act as an antibacterial coating and a coating composition having high corrosion resistance in foul fuel media (Jointly with TATA STEEL; 1401/KOL/2012)
2. A method for recovery of copper from spent lithium ion batteries (0275NF2015/IN)
3. An improved microbial process for dephosphorisation of LD slag (Jointly with TATA STEEL) [201631007295 dt. 02.03.16]
4. A novel pre-treatment-cum-leaching process for selective extraction and separation of La, Ce and Sc from red mud as oxides (Jointly with NALCO) [201631044861 dt 29.12.16]
5. A process for selective extraction of lanthanum, cerium and neodymium from blast furnace slag as oxalates/oxides (Jointly with TATA STEEL) [201631007470 dt. 03.03.16]

**Submitted**

1. A process for microbial desulphurization of high sulfur coals
2. A microbial process for bioleaching of zinc tailings and biosynthesis of zinc oxide nanopowders
3. Process for microbial upgradation of iron ore slimes (Jointly with TATA STEEL)
4. A hydrometallurgical process for extraction of metal values from spent lithium ion EV batteries (Jointly with Renault Nissan Tech Business Centre, India)
5. A biochemical method for selective extraction of metal values from spent lithium ion EV batteries (Jointly with Renault Nissan Tech Business Centre, India)

**INDUSTRIAL & RESEARCH COLLABORATIONS**

* ***Indian:*** UCIL; HCL; HZL; Sterlite Copper; Vedanta Aluminium; Binani Zinc; Himadri Group, Kolkata; Nikshepa Biomining Corporation, Bangalore; OMC; TATA STEEL; NALCO; Renault Nissan R&D India Centre ; MSPL, Hospet; Birla Copper, Dahej
* ***International:*** Arafura World Resources, Perth; CSIRO, Perth; CMRDI, Cairo; ISCEOR & ICCT of Siberian Branch of Russian Academy of Sciences, Krasnoyarsk, Russia; SDU, Turkey; CETEM, Brazil

**AWARDS AND HONOURS**

* Mishra Award for best paper presented in Bioprocessing at IIME’s MPT-2006, Chennai
* Mishra Award for best paper presented in Bioprocessing at IIME’s MPT-2007, Mumbai
* Second Prize, International Microbiology Photograph Competition, Switzerland, Oct, 2009
* Adjudged among “Top-10” in all consecutive Fluka Microbiology Photograph Competition since 2010
* Mishra Award for best paper presented in Bioprocessing at IIME’s MPT-2011, Udaipur
* Young Scientist Award in Engineering Sciences by ISCA at 100th Indian Science Congress, 2012, Kolkata
* 1st Prize in Oral Paper Presentation in “Raw Materials Category” at IIM’s NMDATM2012,Jamshedpur
* 1st Prize in Oral Paper Presentation in “Nonferrous Category” at IIM’s NMDATM2012,Jamshedpur
* 2nd Prize in Oral Paper Presentation in “Raw Materials Category” at IIM’s NMDATM2012,Jamshedpur
* 1st Prize in Poster Presentation in “Nonferrous Category” at IIM’s NMDATM 2013, Varanasi
* 2nd Prize, International Microbiology Photograph Competition, Switzerland, Oct, 2013
* Young Scientist Award in Environmental Microbiology by Association of Microbiologist, India, 2013
* Young Scientist Award in Nuclear Fuel Processing (bioleaching of uranium) by Indian Nuclear Society, DAE, 2013
* Young Scientist Award in Mineral Biotechnology by Biotech Research Society of India, 2014
* Young Metallurgist Award in Nonferrous Metallurgy by Ministry of Steel & Mines, Govt of India, 2014
* Mishra Award for best paper published in the area of Extractive Metallurgy by IIME for 2013-14
* Prof. H.J.Arnikar Best PhD. Thesis awarded by Indian Assoc. Nucl. Chem. Allied Scientists (DAE), 2015
* 1st Prize in Poster Presentation at Nat. Sem. Recent Advances in Biotechnology, April, 2015, Kolkata
* 2nd Prize winner: Metallurgical Research & Technology 2015 Best Paper Award (January 2016) - *Bioleaching of low grade granitic chalcopyrite ore by hyperthermophiles: Elucidation of kinetics-mechanism*
* Outstanding Review Status given by Elsevier's Annals of Nuclear Energy (Nov 2015)
* Article cited on cover page of Indian Journal of Geomarine Sciences (2015)
* TAMOTIA Award for Best Paper Presented in Environmental Management by IIME at MPT-2017, Chennai
* Awarded Membership by National Academy of Sciences, India, 2017
* Young Engineer Award by Mineral Engineering Science Association, Vishakapatnam, India (2017)

**PUBLIC AND PROFESSIONAL SERVICES**

**FELLOWSHIPS & PROFESSIONAL AFFILIATIONS/MEMBERSHIPS**

* ***Fellow –*** Society for Applied Biotechnology, India
* ***Affiliated Member -*** National Academy of Sciences, India; IUPAC
* ***Life Member –*** Indian Institute of Mineral Engineers (IIME), Indian Institute of Metals (IIM); Association of Microbiologists of India (AMI); Indian Nuclear Society (INS); Biotech Research Society of India (BRSI); Indian Association of Nuclear Chemists and Allied Scientists (IANCAS); Materials Research Society of India (MRSI); Indian Science Congress Association (ISCA); Kerala Academy of Sciences (KAS); Administrative Staff College of India (ASCI); Society of Biological Chemists, India (SBC); National Academy of Biological Sciences, India (NABS); Chemical Research Society of India (CRSI);
* ***Subscription Member-*** Society for Applied Microbiology, U.K. (SFAM); Society of Industrial Microbiology, U.S. (SIM); The Minerals, Metals & Materials Society (TMS), US; Asia-Pacific Chemical, Biological& Environmental Engineering Society (APCBEES); European Federation of Biotechnology (EFB-FEMS); American Society of Microbiology (ASM); Indian Society of Education and Environment (ISEE); International Association of Chemical Engineers

**COMMITTEE INVOLVEMENTS (CONF./ACADEMIC)**

* Program Committee Chair, Int. Conf. on Chem. Biol. Environ. Engineering, China, Dec, 2009
* Member, Research Group on Possibilities of Valuation of H2S in Black Sea (FP7-EU)
* Member Expert, TPC-Biomineral Processing, IEEE-World Cong. Eng. Technol., China
* Member, Application of Mat. Chem. Eng.(AMCE), World Academic Publishing, US
* Member, Program Committee, Int. Conf. Metall. Technol. Mat. (ICMTM-2012), Korea
* Member, Technical Committee, Conf. Environ. Poll. Pub. Health (CEPPH 2012), China
* Member, Editorial Board, 15th Int. Conf. on Nonferrous Metals, 2011, Kolkata, India
* Chairman, Editorial Board, 16th Int. Conf. Nonferrous Metals, 2012, New Delhi, India
* Member, Editorial Board, 17th Int. Conf. on Nonferrous Metals, 2013, Ranchi, India
* Chairman, Editorial Board, 18h Int. Conf. Nonferrous Metals, 2014, Nagpur, India
* Co-Chairman, Editorial Board, 19th Int. Conf. on Nonferrous Metals, 2015, Bhubaneswar, India
* Member, Editorial Board, 20th Nat. Conf. on Nonferrous Metals, 2016, Jamshedpur, India
* Adhoc Reviewer- IMPC-2010, Australia; IMPC-2012, India; IBS-2011, China
* PhD Examiner-reviewer for Dept. of Microbiol-Biotechnol, Gujarat Univ., India; BIT, Mesra
* Int. Committee Member, SIPS-2015, Antalya, Turkey
* Member, Emirates Association of Chemical, Biological & Environment Engineers
* Scientific Board member, Institute of Research Engineers and Doctors
* Scientific Board member, International Institute of Chemical, Biological & Environmental Engineering (IICBEE)

**JOURNAL INVOLVEMENTS**

* Editorial Board Member, Russian Journal of Nonferrous Metals (Springer)
* Founding Editor, International Journal of Nonferrous Metallurgy, U.S. (SCRIP)
* Member, Editorial Board, International Journal of Environmental Protection, US
* Member, Editorial Board, Scientific Journal of Environmental Sciences, US
* Associate Editor, International Journal of Advanced Research, India
* Member, Advisory Board, World Research Journal of Environment and Waste Manage., US
* Member, Editorial Board, CIBTECH Journal of Microbiology and Biotechnology
* Member, Editorial Board, Materials Science: Material Review
* Reviewer to International SCI and Non-SCI Journals (Elsevier, Springer, SAGE, ACS, RSC, Wiley, OMICS, etc)

**CONFERENCES/SYMPOSIA/SEMINAR/WORKSHOPS ORGANISED**

* Member, Organising Committee, Training Programme on Extraction of Non-Ferrous Metals and their Recycling (NFTP-2008) at NML, Jamshedpur in Feb, 2008
* Member, Organising Committee, Training Programme for UCIL’s Management Trainees on Mineral Processing and Extractive Metallurgy (MPEM-2008) at NML, Jamshedpur in July, 2008
* Member, Organizing Committee- INCOME 2008, NML, Jamshedpur, Dec 2008; MINETECH-2010, Bhubaneswar, May 2010; MPT-2010, NML, Jamshedpur, Dec 2010; CSIR’s SSBMT Indoor Sports Finals, NML, Jamshedpur, April 2011; LGO-2013, NML, Jamshedpur, Feb 2013; MMCA-2013, NML, Jamshedpur, Nov 2013

**LECTURES DELIVERED**

* Lecture entitled **“Uranium Hydrometallurgy”** at “Training Programme on Mineral Processing and Nonferrous Extractive Metallurgy” for Mgmt. Trainees of M/s UCIL, Jaduguda; held at NML, Jamshedpur from 30th June to 5th July 2008
* Keynote Lecture on **“Bioremediation and Resource Utilisation”** at “National Seminar on Environmental Bioremediation Technologies”, held at Bharathidasan University, Tiruchirapalli, India, 5-6Nov. 2009
* Invited Lecture on **“Microbial composites in effluent remediation”** at “Third International Multicomponent Polymer Conference”, held at MGU, Kottayam, India, 23-25 Mar. 2012
* National Science Day Lecture on **“Role of Biotechnology for Shaping Future of Science”** delivered at The Institution of Engineers, Jamshedpur, India, 6th Feb 2013.
* Invited Lecture on **"Mineral Biotechnology - an inherent tool for mining industry"** at Department of Microbiology and Biotechnology, Gujarat University, Ahmedabad, India, 22-23rd March 2013
* Invited lecture on **“Trends and issues in Science Research”** at National Workshop on Research Methodology in Basic Sciences, Engineering and Technology, organized by Associations of Indian Universities and Pt. Ravishankar Shukla University, Raipur, 29th Aug to 2nd Sept 2013, .
* Invited Keynote Lecture delivered on **“Thermophilic bioleaching of chalcopyrite”** at ICHM-2014, Beijing, China
* Invited Resource Lecture on **“Role of Microbiology in Minerals-Metals-Materials and Environment Sector”** at National Seminar on Dynamic Microbes at Modern College, Pune, India, 20-21st Feb 2015
* Invited Lecture on **“Applications of microbial biotechnology in metallurgical industries”** at BRSI’s National Seminar on Recent Advances in Biotechnology, IICB, Kolkata, India, 17th April 2015
* Invited Lecture on **“Recycling of HEV batteries”** at IITM's workshop on "Status of EV recycling in India", IIT, Madras, India, 25th November 2016
* Invited Speaker on **“Sustainable recycling of Mine and Urban Wastes by Environmentally Benign Options”** at International Symposium on Sustainability in Science and Engineering , organized by IITB, Ohio State University and TechStain, at IITB, 26th July 2017
* Invited Speaker at "International Conference on Advanced Engineering Functional Materials (ICAEFM 2017), to be held in Bhubaneswar, Odisha, India (21-23, Sep 2017)
* Invited Speaker at “3rd India International Science Festival (IISF-2017)”, 13-16th October 2017 **(Theme: Swaach Bharat; Topic: Sustainable End-of-life Closed Loop Recycling of Battery Wastes)**.

**FOREIGN VISITS**

* **EGYPT:** MINERALS TO MATERIALS CONFERENCE - 2008, organized by Central Metallurgical Research and Development Institute (CMRDI), Egypt,15th- 18th December, 2008.
* **AUSTRALIA:** ALTA-2010, organized by ALTA Metallurgical Services, Perth, Australia, 24-29th May, 2010.
* **RUSSIA:** Bilaterial Exchange visit Programme under Indo-Russian Collaboration and Oral Paper Presentation at IIIrd International Congress on Nonferrous Metals 2011(31.08.2011-14.09.2011) in Krasnoyarsk.
* **CHINA:** 3rd International Conference on Asian Nuclear Prospects (ANUP-2012), organized by Tsinghua University (Beijing), INS, IAEA, CAN and KAERI, 16-19th October, 2012.
* **CHINA:** XXVIth International Symposium on Environmental Biogeochemistry (ISEB-2013), Wuhan, China, 13-18th October 2013.
* **CHINA:** 6th International Conference on Hydrometallurgy (ICHM-2014), Beijing, China, 16-19th Oct, 2014.

**TRAINING UNDERTAKEN**

* School on Mineral Biotechnology, at IISC, Bangalore in December 2009
* Short Course on Heap Leaching at ALTA 2010, Perth, May 2010.
* Change Leaders Workshop, at NML, Jamshedpur in August 2010
* Training Program on Technology Valorization and Management, at ASCI, Hyderabad in Feb 2011.
* Career Development Workshop, M/s Groman Consulting S.A., at NML, Jamshedpur, Dec 2011.

**STUDENTS GUIDANCE/TRAINING IMPARTED**

* Classes for ACSIR students, New Recruit Scientists and National/International Interns
* Summer Training: 20 (B.Tech/B.Sc./M.Sc.)
* Dissertation:17 (M.Sc.); 03(M.Tech)

**REFEREES**

1. Dr.B.D.Pandey, Former Chief Scientist and Head, Metal Extraction & Forming Division, CSIR-NML, Jamshedpur, INDIA; Email: [bdpnml@gmail.com](mailto:bdpnml@gmail.com)
2. Prof. K.A.Natarajan, NASI Fellow and Hon. Professor, Dept. of Materials Engg., IISC, Bangalore, INDIA; Email: [kan@materials.iisc.ernet.in](mailto:kan@materials.iisc.ernet.in)
3. Professor Ata Akcil, *Group Leader,* Mineral - Metal Recovery and Recycling (MMR&R) Research Group, S.D. University, TURKEY; Email: [ataakcil@sdu.edu.tr](mailto:ataakcil@sdu.edu.tr" \t "_blank)
4. Prof. Anna Kaksonen, CSIRO Land and Water, Floreat, Western Australia, AUSTRALIA; Email: [anna.kaksonen@csiro.au](mailto:anna.kaksonen@csiro.au)
5. Prof. Yen Peng Ting, Associate Professor, Department of Chemical and Biomolecular Engineering, NUS, SINGAPORE; Email: [chetyp@nus.edu.sg](file:///C:\Users\Abhilash\Desktop\chetyp@nus.edu.sg)