

NEWSLETTER

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Message from The Director

We are pleased with the positive reception of our Newsletters which are designed to provide our industrial, commercial and academic readership about the vision, mission, current R&D activities, manpower training events as well as future plans of M3TC. We also plan to highlight the accomplishments of our researchers and provide access to the outcomes so that industry in particular can benefit from it. It is also an opportunity for industry and business in the minerals, metals and materials processing sector to partner with M3TC and leverage on the expertise and sophisticated research facilities available within the Faculty of Engineering at NUS.



Our newsletters include information on ongoing R&D projects, our contacts with industry and academic institutions in Singapore as well as the region. We also provide contact information to speed up access to M3TC expertise to potential industry partners. We invite readers to contact us for relevant information.

We have also appointed a Business Development Officer who will reach out to industry, make them familiar on ways in which M3TC can help industrial R&D with R&D projects as well as consulting services. Please refer to Staff Changes section for details.

Finally, best wishes to all our readers for a happy, prosperous and productive Year of the Dragon.

Professor Arun S Mujumdar
NUS, Singapore

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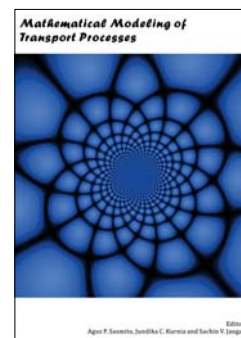
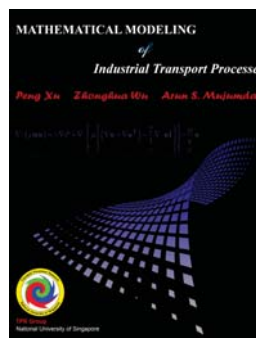
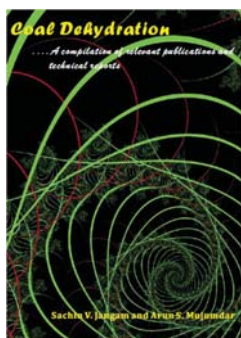
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E-books for download



M3TC research staff have published several e-books on the topics of wide interest such as Mathematical Modeling of industrial transport processes, heat and mass transfer and drying which are available for free download on M3TC website. Interested readers may wish to visit this link for more details.

http://www.eng.nus.edu.sg/m3tc/e_books.html

M3TC Staff Changes

Mr Karthik Somsundaram
has joined M3TC as

Business Development Officer

His main job will be to develop contacts with industry, business and government agencies in Singapore and the region to bring in appropriate R&D projects to M3TC under the supervision and guidance of Director R&D.

Dr. Agus Pulung Sasmito
Research Fellow

Dr. Agus working on Mine Ventilation project will soon join as a Research Fellow at

Masdar Institute, Abu Dhabi

Recent Seminars

Dr. R.A. Mashelkar (National Research Professor and President of Global Research Alliance) gave an inspiring, illuminating and instructive 90-minute lecture to over 150 participants at NUS on 19th January 2012. The theme focused on his MLM (More for less for more!) model of innovation. It is applicable to developing as well as developed nations. The key objective is to enhance access for the general global population- not just for some but for all.

Dr. O. P. Karthikeyan, a Research Fellow at M3TC, delivered a seminar on "Bioleaching of Precious Metals From Mineral Ores". Professor Rajasekhar Balasubramanian is the Principal Investigator for this project

Date: January 30, 2012

International visits

Professor Mujumdar's visit to Institute of Chemical Technology (ICT), Mumbai, India

Professor Mujumdar visited Institute of Chemical Technology (ICT), Mumbai in December 2011. He presented a seminar entitled "Perspectives on Globalization, Innovation and R&D" to graduate students and faculty members of ICT. He toured the excellent facilities of the Bioenergy Centre funded by the Department of Biotechnology (Govt. of India). He also met with Professor J. B. Joshi (DAE-Homi-Bhabha Distinguished Chair Professor and J. C. Bose Fellow Institute of Chemical Technology) and had extensive discussions on M3TC R&D areas. Prof. Joshi's research groups specialize in fundamental research in transport phenomena and applications to chemical, petrochemical, nuclear and mineral processing industries. For example, his group has successfully developed patented processes to reduce electrical power consumption in electrochemical production of aluminum by about 30%. Also, they can now produce titanium at the cost of production of aluminum- a process that can revolutionize the industrial production of titanium. Based on mathematical modeling they have developed liquid-liquid extractors that are hundred times smaller in volume than their current counterparts. Indeed, this is a dramatic case of how modeling can be used effectively for process intensification and novel designs. Their group is also developing a simulation model for an entire nitric acid plant. Overall, the visit was extremely valuable for M3TC as this has potential to lead to mutually beneficial collaboration in R&D. Parenthetically, it is interesting to note that ICT ranks number 4 in the world in terms of journal publications of a chemical engineering department according to a study published by Professor Jude Sommerfield of Georgia Institute of Technology.



Dr. R.A. Mashelkar (National Research Professor and President of Global Research Alliance) during his seminar on More from Less for More (MLM)

Conference keynote invitation

Prof. Mujumdar has been invited to deliver a keynote address on M3TC at Symposium on "New Equipment New Technology Management and Safety in Mines and Mineral Based Industries" to be held in Bhubaneswar, India, May 2012

The title of his address will be "M3TC – A New Model for Academia-Industry Interaction"

Completed Projects

Advanced Processing for Powder Metallurgy (P/M) – High Performance and Cost Effective Materials

The main objective of the project is to develop cost-effective processing techniques and material compositions for high-end and high value-added applications, focusing on transparent ceramics and textured piezoelectric ceramics that have great applications in the local industry. The industry collaborator was Dou Yee Technologies Pte Ltd (DYT), a member of Dou Yee International, Singapore.

Alumina (Al₂O₃) specimens were fabricated and sintered at different temperatures in a vacuum condition to investigate the effect on translucency. Polycrystalline alumina samples with desirable transparency were successfully fabricated. It was found that the degree of transparency is highly correlated to the microstructure. Poor transparency was due to the presence of secondary phases along the grain boundaries, porosity and abnormal grain growth. The optimum sintering temperature and time, that is 1850 °C for 30 min, were used for the fabrication of translucent alumina to achieve the highest density and minimum porosity. After project completion, we continued to investigate the effect of dopants and colloidal processing on the transparency of sintered alumina to explore more effective and efficient techniques. Magnesium oxide (MgO) and Lanthanum (III) Oxide (La₂O₃) were chosen as dopants. The experimental results proved that the addition of small amount of dopants could suppress or eliminate abnormal grain growth and increase transparent level. The light transmittance, microstructure and relative density of sintered alumina samples were measured and examined to find out the optimum processing parameters and dopant amounts. Colloidal processing is an effective method to break up soft agglomerates existed in fine powders. After colloidal processing, the relative density of pure alumina samples raised from 85.0% to 98.3%, which made a significant improvement.

Texture engineering aims to optimize the microstructure of ceramics such that the textured ceramics could possess single crystal like properties with lower cost. During the project period, lead zirconate titanate (PZT) based materials were investigated, which have been dominating the market of piezoelectric materials for decades due to their excellent dielectric properties and piezoelectric properties. However, PZT contains up to 60 wt% of lead which is a toxic element. The lead evaporation and the electronic waste containing lead not only are harmful for human, but also cause serious environmental issues. Therefore, it is of great interest to develop lead-free piezoelectric materials to replace PZT. Using the reactive templated grain growth method proposed in the project, we tried to develop high performance and lead free textured piezoelectric ceramics (Ba,Ca)(Ti,Zr)O₃. Plate-like BaTiO₃ powders were selected as template since the structure of BaTiO₃ is close to that of BCTZ and the diffusion direction is easy to control. In addition, without introducing foreign elements, the properties will not deteriorate if large amount of template is needed. A two-step molten salt synthesis was adopted to produce plate-like BaTiO₃ template particles. Carbonates and oxides were used to synthesize (Ba,Ca)(Ti,Zr)O₃ powder by high energy ball milling. During the preparation of the slurry for tape casting, the powder was ball milled with solvent and dispersant. Binder and plasticizer were then added into the previous slurry. Finally BaTiO₃ templates and compensated powders were added into the slurry for a gentle ball mill. Then green sheet was formed by tape casting with a doctor blade. The green sheet was cut, laminated, and pressed to form green compact. After organic additives were burned out, the samples were sintered to form dense ceramics. The experiment results revealed that the ceramics with 5 mol% of BaTiO₃ template had the highest degree of orientation. Compared with the ceramics sintered by conventional solid state reaction, the properties of the highly textured ceramics have improved more than 30%. With the dramatically improved properties, the textured BCTZ ceramics can be a promising candidate of lead free piezoelectric ceramics.

Several publications have appeared that give details of the results of this M3TC sponsored R&D project.

Contact: Jerry Fuh, Lu Li and Ma Sha
Department of Mechanical Engineering

Upcoming workshops/seminars

A M3TC workshop will be held in conjunction with the 5th Asian Particle Technology Symposium (APT2012)
July 02-05, 2012

Venue - Faculty of Engineering,
National University of Singapore

Principles & Modeling of
Underground Mine Ventilation
Systems
Date- TBA

Speakers
Dr Poh Hee Joo, IHPC,
Dr. Erik Birgersson, NUS
Dr Jundika Kurnia, M3TC/NUS

Professor Y. Itaya of Gifu
University, Japan will visit M3TC
as a visiting faculty

during - September 2012

He will deliver seminars on Clean
coal technology and Upgrading of
low rank coals

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Recent Publications

Climate Change Mitigation- IPPC Report

The Intergovernmental Panel on Climate Change (IPCC) has published its extensive Special Report on Renewable Energy Sources and Climate Change Mitigation. This 1075-page report is published by Cambridge University Press, 2012 (ISBN 978-1-107-02340-6). This report is distilled from the contributions of 122 selected lead authors and 25 Review Editors. M3TC is pleased to note that our Director, Prof. Arun Mujumdar, was invited to be one of the contributing authors of this truly mammoth effort. His contribution focused on solar-assisted drying which identified current status and needs for further developments in this area.

Recent Book

Tsotsas I. and Mujumdar A.S. (Ed), Modern Drying Technology - Volume 4, Wiley Interscience: Germany, 2011.
ISBN: 978-3-527-31559-8

Modern Drying Technology, a multivolume work covers drying, a key industrial processes that accounts for about 10-percent of total energy consumption in industry. It guides engineers towards achieving energy savings through such approaches as improved apparatus design, optimization, and heat recovery. In so doing, it points the way to success for both researchers and practitioners in mastering this multiphase and multiscale process.



Conference publications

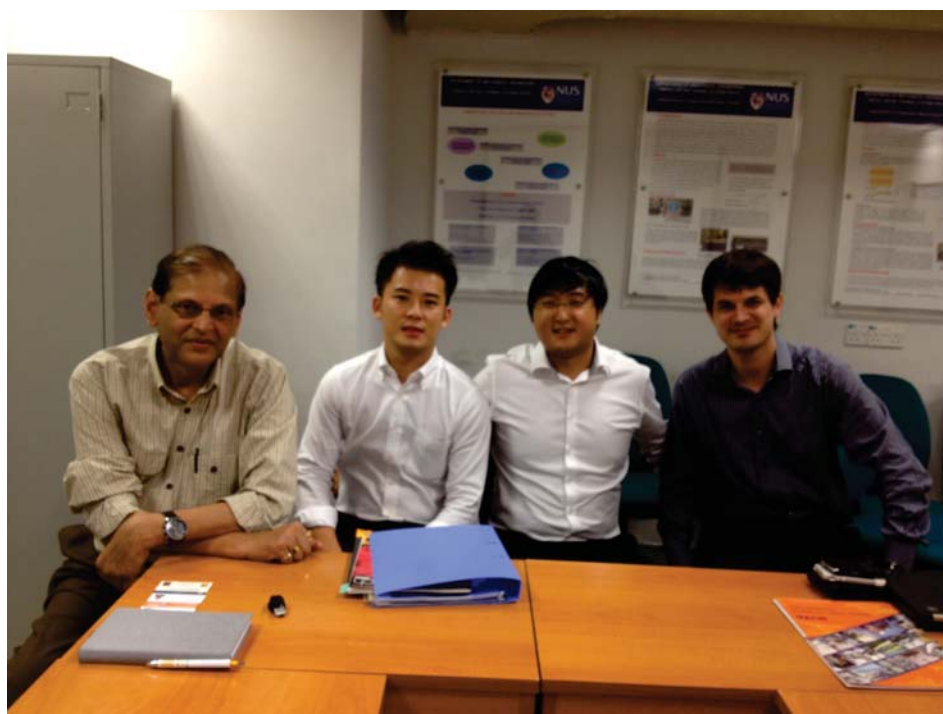
A. Rajasekar, C-J. Hsien and R. Balasubramanian (2011). "Bioleaching of metals (Cu, Fe and Ag) from chalcopyrite ore by Acidiphile group of bacteria". IV International Conference on Environmental, Industrial and Applied Microbiology (BioMicroWorld2011), Torremolinos (Spain), 14-16 September 2011 (Oral Presentation, Page No. 98).

R. Balasubramanian, A. Rajasekar, O.P. Karthikeyan, A. Szubert, A. Grotowski, J.D. Lease (2011). "Bioleaching of precious metals from mineral ores: current challenges and future prospects". Presented in International conference, Poland, October 26-29, 2011.

A. Rajasekar, O. P. Karthikeyan, S. Manivannan and Rajasekhar Balasubramanian (2011). "Comparative Evaluation of Two Bioreactors for Bioleaching of Cu, Fe and Ag from chalcopyrite by Leptospirillum ferrooxidans". IV International Conference on Environmental, Industrial and Applied Microbiology (BioMicroWorld2011), Torremolinos (Spain), 14-16 September 2011 (Poster Presentation, Page No. 104).

O. P. Karthikeyan, A. Rajasekar, S. Manivannan and Rajasekhar Balasubramanian (2011). "Bioleaching of precious metals from low-grade copper ores using mixed consortium in air-uplift bioreactors: performance evaluation under single and two stage configurations". IV International Conference on Environmental, Industrial and Applied Microbiology (BioMicroWorld2011), Torremolinos (Spain), 14-16 September 2011 (Oral Presentation, Page No. 295).

Industry Contacts



Meeting with Agritrade International Pte Ltd, Singapore

From left - Prof Arun Mujumdar (Director M3TC), Mr Choon Leong (Operations Executive, Agritrade), Mr. Xin wei (commissioner, Agritrade) and Dr. Jeremy Lease (Project Manager, M3TC)

A M3TC research team working on Coal Drying project had meetings/discussion with following coal companies

*PT. Thriveni, Indonesia
Agritrade, Singapore*

Highlights of the meetings

Both companies have shown strong interest to carry out collaborative work with M3TC

M3TC research team will visit GeoCoal pilot scale facility (Agritrade) to provide suggestions for any changes required

M3TC research team plans to visit the Thriveni coal mine in Sumatra