Buletin Pusat Pengajian Kejuruteraan Bahan dan Sumber Mineral
Bulletin for the School of Materials and Mineral Resources Engineering
Universiti Sains Malaysia

ENJINIER

JIL. 06 BIL. 02 No. ISSN: 1511-5275 http://www.usm.my Dis 2004

PINGAT EMAS Di IENA, Nuremberg German

Oktober 2004 - Prof Radzali Othman dan kumpulan penyelidiknya sekali lagi mengharumkan nama USM dan pusat pengajian apabila hasil penyelidikan beliau bersama kumpulan penyelidik dari Pusat Pengajian Sains Pergigian melalui penyelidikan mereka "REKAGRAF - Reformulated Calcium Phosphate for Human Tissue Transplantation (Synthetic Bone) mendapat pengiktirafan dunia dengan merangkul pingat emas dalam pameran antarabangsa untuk idea, rekacipta dan barangan baru (International Trade Fair - Ideas-Inventions-New Products (IENA 2004) di Nuremberg German pada 28 - 31 Oktober lalu.

Prof Radzali dan ahli kumpulannya berjaya menghasilkan tulang sintetik yang selamat dan mudah digunakan berasaskan bahan yang murah untuk dihidapi manusia dan haiwan. Kejayaan ini membuktikan produk tempatan mampu bersaing sehingga ke peringkat global adalah amat dibanggakan. Syabas dan tahniah dari semua warga PPKBSM. Semoga kecemerlangan ini menjadi pendorong kepada semua untuk merealisasikan hasrat universiti untuk terus gemilang hingga ke peringkat antarabangsa seterusnya mengharumkan nama univesiti dan negara.

MAMIP- 2004: Pasca Siswazah: Pemangkin Penyelidikan Dan Inovasi

7-8 Oktober 2004 - Kolokium Penyelidikan Pasca Siswazah (MAMIP 2004) kali kedua telah berjaya diadakan di Hotel Vistana, Pulau Pinang. Kolokium ini telah dianjurkan oleh Pusat Pengajian Kejuruteraan Bahan & Sumber Mineral (PPKBSM) dengan kerjasama Kelab Ijazah Tinggi PPKBSM sebagai kesinambungan kejayaan kolokium pertama penyelidikan pasca siswazah yang telah diadakan pada tahun 2000 di samping sebagai salah satu aktiviti sambutan ulang tahun ke-35 penubuhan USM dan ke-20 penubuhan PPKBSM. Majlis perasmian telah disempurnakan oleh Timbalan Naib Cancelor Hal Ehwal Akademik USM, Dato' Profesor Dr. Syed Ahmad Hussein. Dalam ucapan perasmiannya, beliau telah menekankan pentingnya penglibatan golongan pelajar pasca siswazah di dalam kemajuan sesebuah negara dan ia amat berkait rapat dengan peningkatan dalam bidang penyelidikan selaras dengan tema yang dipilih iaitu Pasca Siswazah: Pemangkin Penyelidikan dan Inovasi.

Gambar kenangan para peserta MAMIP 2004 bersama TNC Hal Ehwal Akademik Dato'

Sidang Pengarang

Prof. Hanafi Ismail
(Ketua Pengarang)

Ir. Dr. Mior Termizi Mohd Yusof

Prof. Zainal Arifin Ahmad

Dr. Azura A. Rashid

Encik Samayamutthirian Palaniandy

Encik Mohd Nazri Idris

Penolong Pengarang

Mohd Al Amin Muhamad Nor

Yeoh Cheow Keat

Peserta bengkel Perlindungan Katodik 2004 bergambar kenangan di hadapan bangunan Pusat Pengajian Kejuruteraan Bahan dan Sumber Mineral

Kolokium ini telah berjaya menarik hampir 100 orang peserta di dalam dan luar negara. Lebih 100 kertas kerja telah dibentangkan meliputi bidang kejuruteraan bahan, sumber mineral dan polimer. Tiga pembentang ucaptama telah dijemput iaitu Dr. Talib Ria Jaafar dari SIRIM AMREC dengan kertas kerjanya bertajuk; Friction Materials for Braking Application, Ir. Selamat Aliman dari Institut Kejuruteraan Mineral Malaysia dengan kertas kerja bertajuk Minerals and Sustainable Development-Cinsideration for Malaysian Needs dan Prof. M. Nasir daripada Universiti Industri Selangor (UNISEL) dengan kertas kerja bertajuk Research and Development and Commercialization. Upacara penutup telah dilakukan oleh Prof. Madya Dr. Azizan Aziz selaku Timbalan Dekan Penyelidikan Dan Pasca Siswazah PPKBSM dan juga selaku penasihat MAMIP 2004. Apa yang diharapkan melalui penganjuran kolokium ini telah memberikan ruang kepada para pelajar ijazah tinggi PPKBSM khususnya bukan sahaja dari aspek penganjuran malahan yang lebih utama ialah aspek penulisan dan pembentangan kertas kerja teknikal.

Bengkel Perlindungan Katodik

27-28 September 2004 - Pusat Pengajian ini dengan kerjasama Institute of Materials Malaysia (IMM) Northen Region telah mengadakan satu lagi bengkel bertajuk Perlindungan Katodik: Prinsip, rekabentuk dan pemeriksaan yang telah diadakan di bilik seminar PPKBSM. Bengkel yang dipengerusikan oleh Prof. Madya Dr. Ahmad fauzi Mohd Nor ini melibatkan enam orang pembentang kertas kerja yang terdiri daripada Prof. Madya Dr. Luay Bakir Hussien, Dr. Hazizan Md Akil, Dr. Purwadaria, En. Ahmad Badri Ismail dan En. Kang K. Ang daripada IMM. Sesi amali telah dikendalikan oleh Dr. Sunara dan Prof. Dr. Zainal Arifin Ahmad. Bengkel ini melibatkan hampir 30 orang peserta daripada pelbagai egensi termasuk pusat pengajian ini sendiri. Matlamat bengkel ini diadakan adalah untuk mendedahkan pemahaman yang mendalam terhadap prinsip-prinsip asas dalam perlindungan katodik, aplikasi dan faktor-faktor yang membataskan penggunaannya. Bengkel ini juga turut mendedahkan pelbagai teknik yang menyeluruh dan terperinci berkaitan rekabentuk perlindungan katodik dan kaedah pemeriksaan yang digunakan. Keseluruhan penyampaian dalam bengkel ini amat menarik minat para peserta dan bagi pihak jawatan kuasa bengkel turut berterima kasih di atas penglibatan yang menggalakkan daripada semua pihak.

Lawatan daripada Universiti Prince of Songkhla

7-8 Oktober 2004 - Pusat pengajian sekali lagi berbesar hati menerima kunjungan daripada tenaga pengajar Universiti Prince of Songkhla. Lawatan selama 2 hari ini dipenuhi dengan aktiviti perbincangan dalam usaha mewujudkan kerjasama antara PPKBSM dan Universiti Prince of Songkhla.

Sepanjang lawatan, mereka telah di bawa melawat sekitar makmal PPKBSM dan berbincang bersama tenaga pengajar dalam jurusan masing-masing. Hasil perbincangan telah menunjukkan satu persetujuan positif di mana PPKBSM akan membuat satu lawatan balas ke Universiti Prince of Songkhla seterusnya menandatangi perjanjian persefahaman (Memorandum of Outstanding - MoU) untuk bekerjasama pada masa akan datang

Kontigen PPKBSM bergambar kenangan di hari warga staf 2004

Hari Warga Staf Kampus Kejuruteraan

November 2004 - Hari warga staf kejuruteraan muncul lagi dengan tema 'Keranamu Kejuruteraan' yang diadakan pada 26 November 2004. Hari warga staf ini dibahagikan kepada dua sesi iaitu sesi sukaneka dan sesi malam persembahan. Sesi sukaneka berlangsung pada jam 2.30 petang di Kompleks Sukan di mana Staf diletakkan di bawah 9 kontigen yang diketuai oleh Dekan atau Ketua Jabatan masing-masing dan bertanding bagi merebut gelaran juara bagi perlbagai acara sukaneka seperti Formula One, Sepatu Lipan, Lompat Jalur dan sebagainya. Manakala sesi malam persembahan pula berlangsung di Dewan Utama mulai jam 8.00 malam. Bertemakan 'Malam Senandung Aidil Fitri' membawa penonton menyaksikan persembahan menarik oleh staf termasuk nyanyian solo. Sambil menjamu selera dan menyaksikan acara persembahan, para penonton berpeluang membawa pulang hadiah-hadiah menarik bagi acara cabutan bertuah.

Sempena hari warga staf ini, warga PPKBSM ingin mengucapkan tahniah dan syabas kepada kontigen PPKBSM yang telah berjaya meraih tempat kedua bagi kategori pasukan terbaik dan rakan-rakan yang memenangi acara sukaneka. Acara tahunan ini dapat mengeratkan silaturrahim antara kita dengan kemeriahan yang dirasai untuk memenangi acara sukaneka dan kerjasama erat dalam menghias khemah walaupun kontigen PPKBSM tewas kepada kontigen PPKEE yang berjaya muncul sebagai pemenang khemah terbaik.

Jutaan terimakasih dan penghargaan turut bersama menjayakan hari Warga Kampus Kejuruteraan terutama kepada semua ahli dalam Jawatankuasa Hiasan Dewan yang diketuai oleh Dr.Mariatti Ja'afar dan Jawatankuasa Persembahan yang diketuai oleh Dr.Zulkifli Mohamad Ariff. Kehadiran dan sokongan daripada semua amat dihargai dan perlu diteruskan pada masa akan datang. Acara tahunan ini adalah untuk meraikan staf yang ada di samping menjalin hubungan erat sesama kita dalam merealisasikan hasrat universiti untuk mewujudkan Kampus Sejahtera dapat diteruskan pada masa-masa akan datang.

Bengkel Perancangan Stretegik RM-9 PPKBSM

Disember 2004 - Satu bengkel menjana pelan Rancangan Malaysia ke-9 (RM-9) telah diadakan di Hotel seri Malaysia, Kulim Kedah pada 4-5 Disember 2004. Bengkel ini dihadiri oleh semua staf akademik PPKBSM bagi perbincangan dan memberi idea dalam perancangan untuk Rancangan Malaysia ke-9 PPKBSM. Komitmen dan tanggungjawab yang tinggi telah ditunjukkan oleh semua dalam perbincangan agenda utama iaitu merealisasikan hasrat Pusat Pengajian untuk muncul sebagai sebuah Pusat Pengajian yang tersohor di peringkat global.

Bengkel ini merupakan salah satu usaha pusat pengajian untuk menjalinkan kerjasama erat antara rakan sekerja di luar persekitaran universiti dalam merealisasikan hasrat pusat pengajian untuk mencapai pelbagai misi. Pelbagai isu menarik telah dibincangkan terutamanya isu penerbitan bagi setiap staf akademik dan pelbagai isu hasil semangat berpasukan yang tinggi dan kerjasama erat antara semua. Semoga komitmen berpasukan yang ditunjukkan akan diteruskan pada masa akan datang dalam usaha bersama untuk penambahbaikan PPKBSM tercinta.

Lawatan akademik Kelab Ijazah Tinggi ke PPKK dan InventQjaya

Ogos 2004 - Seramai 40 ahli Kelab Ijazah Tinggi PPKBSM telah mengadakan lawatan sambil belajar ke Pusat Pengajian Kejuruteraan Kimia (PPKK), USM pada pertengahan tahun 2004 yang lalu. Rombongan ini telah disambut oleh kelab ijazah tinggi Kejuruteraan Kimia dan telah diberikan taklimat ringkas berkenaan program ijazah tinggi yang ditawarkan di pusat pengajian berkenaan. Rombongan ini juga telah dibawa melawat di sekitar pusat pengajian termasuk makmal analitikal dan makmal kawalan proses. Ahli rombongan turut diberikan taklimat berkenaan kemudahan-kemudahan makmal yang disediakan dan beberapa aspek kawalan instrumentasi serta kaedah-kaedah analisis yang digunakan secara meluas di dalam industri. Kunjungan ini dapat memberikan beberapa pendedahan penting dan pertukaran maklumat antara sesama para pelajar ijazah tinggi.

Manakala rombongan kedua kelab Ijazah Tinggi PPKBSM turut melakukan satu lagi lawatan akademik ke InventQjaya pada bulan Ogos 2004 dengan disertai seramai 42 ahli dan turut diiringi Prof. Madya Dr. Azizan Aziz yang juga merangkap sebagai Timbalan Dekan Penyelidikan dan Pasca Siswazah. InventQjaya adalah sebuah pusat penyelidikan terkini yang baru ditubuhkan sekitar tahun 2003 dan beroperasi di Cyber Jaya. Rombongan ini telah dibawa melawat ke makmal penyelidikan fotonik, pengangkutan termaju, teknologi nano, bahan termaju dan elektrokimia. Rombongan ini juga telah diperkenalkan dengan hasil kajian yang akan dikomersialkan iaitu 'Metal Fuel'. Produk ini merupakan bateri inovasi baru yang dapat menggantikan penggunaan bateri konvensional sedia ada. Antara penyelidikan lain yang telah dan masih giat dijalankan termasuklah 'First electrical hybrid metal fuelled car' yang telah pun dapat dihasilkan prototaipnya serta 'Eco-friendly solution for renewable electricity for coastal home'. Setelah berakhirnya sessi lawatan, rombongan juga telah dibawa kepada sessi perbincangan dua hala meliputi kerjasama dalam bidang penyelidikan serta peluang-peluang pekerjaan yang dapat ditawarkan

Campus Merdeka Walk 04

Ogos 2004 - Kampus Kejuruteraan telah menjadi tuan rumah 'Campus Merdeka Walk 04' peringkat Universiti pada 26 Ogos 2004 jam 5.00 petang di Kompleks Sukan. 'Campus Merdeka Walk' adalah acara tahunan USM yang diadakan bersempena dengan Sambutan Hari Kemerdekaan Negara pada 31 Ogos 2004. Aktiviti ini telah disertai oleh Timbalan Ketua Menteri Pulau Pinang, Dato' Haji Abdul Rashid Abdullah, Pegawai-pegawai Utama Universiti serta lebih daripada 1,000 orang terdiri daripada staf dan pelajar.

Kontigen PPKBSM merupakan kontigen paling ramai penyertaan pada hari 'Campus Merdeka Walk' ini. Hampir kesemua staf PPKBSM bersama semua pelajar pasca siswazah dan tahun satu serta pelajar tahun 2,3 dan 4 yang tidak terlibat dalam kontigen pakaian beruniform dan desasiswa turun padang memeriahkan acara 'Campus Merdeka Walk' ini. Kontigen PPKBSM memeriahkan suasana dengan membawa 3 kain rentang bertemakan kemerdekaan sumbangan staf PPKBSM, pelajar pasca siswazah dan pelajar siswazah.

Acara 'Campus Merdeka Walk' bermula dengan nyanyian lagu Negara Ku, Negeri Pulau Pinang, Menara Ilmu dan Jalur Gemilang diikuti dengan senamrobik. Para peserta yang diletakkan di bawah kontigen di bawah pusat pengajian masing-masing bergerak berjalan kaki di dalam kawasan kampus dengan diiringi oleh lagu-lagu patriotik. Aktiviti ini diakhiri dengan jamuan makan yang disediakan oleh Pusat Islam, Kampus Kejuruteraan. Sekalung penghargaan kepada semua warga PPKBSM yang turun padang memeriahkan sambutan kemerdekaan yang julung kali diadakan di kampus kita.

1 Perak, 2 Gangsa di Expo Sains dan Teknologi 2004

Ogos 2004 - Pensyarah PPKBSM sekali lagi mencatatkan kejayaan yang dibanggakan dalam Ekspo Sains dan Teknologi 2004 yang berlangsung di PWTC. Kita berjaya meraih satu pingat perak melalui hasil penyelidikan 'FlexiTech Ceramic' oleh Prof. Dr. Zainal Arifin Ahmad dan kumpulan penyelidiknya manakala dua pingat gangsa diperolehi melalui hasil penyelidikan 'Production of light and strong structures from recycled material oleh Prof Madya Dr Luay Bakir Hussain dan kumpulan penyelidiknya dan hasil penyelidikan 'DURAGLASS (Durable Durian and Rambutan Glasses) oleh Prof. Radzali Othman dan kumpulan penyelidiknya. Jumlah pingat ini adalah sebahagian daripada keseluruhan yang pingat yang dimenangi oleh kampus kejuruteraan Universiti Sains Malaysia di pameran tersebut iaitu 3 pingat emas, 6 pingat perak dan 8 pingat gangsa. Syabas dan tahniah dari semua warga PPKBSM.

Ucapan Tahniah ...

di atas perlantikan sebagai Profesor kepada:

Prof. Dr. Hj. Zainal Arifin Ahmad

dan perlantikan sebagai Pensyarah Kanan / Penolong Pendaftar kanan:

Ir. Dr. Mior Termizi Mohd Yusof
Dr. Azhar Abu Bakar
Dr. Azlan Arifin
Dr. Ahmad Marzio Mohd Yusof
En. Mokhtar Al Fakari Anurbek

Tales out of school

A professor at a university had a very simple policy on grading.

"I don't fail students, " he announced in the first class of the semester, which always brought a roar of jubilation.

The cheers quickly stopped when he continued: "But I do not pass any, either.

Students pass and fail themselves."

Sidang Pengarang Enjinier menjemput semua staf, pelajar-pelajar dan graduan PPKBSM memberi sumbangan rencana dan pandangan mereka kepada:

Sidang Pengarang Enjinier,
Pusat Pengajian Kejuruteraan Bahan dan Sumber Mineral,
Kampus Kejuruteraan,
Universiti Sains Malaysia,
14300 Nibong Tebal.

The Enjinier Editorial Board invites all staff, students and graduates of the School of Materials and Mineral Resources Engineering to contribute articles and views to: (Articles must be not more than 3 A4 pages font 12 single spacing)

Enjinier Editorial Board,
School of Materials and Mineral Resources Engineering, Engineering Campus,
Universiti Sains Malaysia,
14300 Nibong Tebal.

Kejayaan Lain 2004

Seluruh warga PPKBSM ingin mengucapkan setinggi tahniah dan syabas terhadap Prof. Zainal Arifin Mohd Ishak atas kejayaan beliau mendapat anugerah Georg Forster Research-Alexander von Humboldt Foundation Germany dan Prof. Hanafi Ismail di atas kejayaan beliau yang menerima anugerah Saintis Cemerlang 2004 - Kementerian Pengajian Tinggi Malaysia. Kejayaan cemerlang kedua professor ini akan menjadi contoh kepada semua warga PPKBS untuk lebih maju di masa hadapan.

Sekalung tahniah juga diucapkan kepada Prof Madya Dr Khairun Azizi dan rakan-rakan atas kejayaan mereka yang menerima anugerah dalam 'Malaysian Construction Industry Excellence Awards 2004 bagi kategori penyelidikan dan pembangunan (R & D) untuk produk mereka "HIQSA: High quality shape aggregates".

AUN/SEED-Net Field-Wise Seminar IV

2-3 Ogos 2004 - Pusat Pengajian kejuruteraan Bahan Dan Sumber Mineral sekali lagi telah berjaya mengadakan satu lagi AUN/SEED-Net Field-Wise Seminar IV, yang bertajuk 'Processing-Properties Relationship in Biomaterials'. Seminar ini telah berlangsung selama dua hari di Sunway Hotel Georgetown, Pulau Pinang dan sepenuhnya telah ditaja oleh AUN/SEED-Net dan Japan International Cooperation Agency (JICA). Seminar ini yang telah dipengerusikan oleh Profesor Radzali Othman, turut dihadiri oleh sebelas orang wakil daripada sebelas institusi-institusi pengajian tinggi di sekitar ASEAN.

Sehubungan dengan itu tiga orang speaker iaitu Profesor Hiroo Iwata, Profesor Mitsuo Niinomi dan Profesor Radzali Othman telah dijemput untuk membentangkan kertas kerja masing-masing. Antara objektif seminar kali ini adalah untuk berkongsi pengalaman dan kerja-kerja penyelidikan antara peserta institusi-institusi terbabit terhadap aplikasi kejuruteraan bahan dan sumber mineral. Seminar ini juga bertujuan untuk menyediakan peluang-peluang kerjasama antara peserta-peserta institusi pengajian yang terlibat di dalam penggunaan bahan termaju dan untuk menyusun semula rangka-rangka perlaksanaan termasuk aktiviti-aktiviti penyelidikan bersama dalam sesuatu bidang. Sehubungan dengan itu seminar kali ini juga diharapkan dapat menguatkan lagi jalinan kerjasama antara peserta-peserta institusi pengajian dengan Japanese Supporting Universities (JSU) di samping mengenalpasti skop penyelidikan untuk pelajar-pelajar ijazah daripada institusi pengajian yang terlibat. Dalam menjayakan aktiviti ini, pihak jawatankuasa yang terlibat turut mengucapkan setinggi-tinggi penghargaan kepada semua pihak yang telah menjayakan seminar ini.

SIJIL DEKAN

PUSAT PENGAJIAN KEJURUTERAAN BAHAN DAN SUMBER MINERAL

SEMESTER 1
SIDANG 2004/2005

KEJURUTERAAN BAHAN

Tahun 1
Sasikumar a/l Arumugam
Yeo Chiew Hwee

Tahun 2
Khoor Siang Tian
Liew Kein Fee
Ong Yee Wei

Tahun 3
Ho Kar Fei
Lim Ling Ching
Lim Shwu Choo
Lim Soo Wah
Loo Siaw Choon
Lum Sek Yew
Ng Mei Chan
Ong Ghee Mei

Tahun Akhir
Cho Cheong Chang
Chua Boon Kwean
Foong Yuan Mei
Kong Chia Wei
Lee Jian Huei
Mok Boon Yong
Soo Siew Suan
Tay Poh Leong
Tee Dee In
Vegneswary a/p Ramalingam

KEJURUTERAAN POLIMER

Tahun 1
Lim Wei Chin

Tahun 2
Ho Kar Wei
Lim Cheng See
Tay Min Min

Tahun 3
Foo Pei Ming
Lam Seow Fong
Ong Soo Shin
Tay Lee Hwa

Tahun Akhir
TIADA

KEJURUTERAAN SUMBER MINERAL

Tahun 1
TIADA

Tahun 2
TIADA

Tahun 3
Dg. Harba Aini Abd. Halim
Hariyanto Salleh

Tahun Akhir
Ee Xun Hong
Khoo Wei Wei
Lee Siew Wee
Oh May Ling

Profesor Kunjungan ke PPKBSM

Jun 2004 - Pusat pengajian telah menerima Prof. Dr. P.Pramanik daripada West Bengal India yang dilantik sebagai profesor kunjungan di INFORMM telah ditempatkan di PPKBSM bermula 28 Jun 2004 selama setahun. Prof. Pramanik yang mempunyai kepakaran dalam bidang bahan terutamanya bidang teknologi nano ditempatkan di PPKBSM untuk membantu dalam bidang penyelidikan yang berkaitan. Semoga kehadiran dan kepakaran beliau di PPKBSM akan memberi manfaat kepada kita untuk terus maju terutamanya dalam bidang penyelidikan yang berkaitan dengan teknologi nano yang mendapat perhatian semua pihak pada masa kini.

MIMATES: Pameran Pusat Pengajian di Konvokesyen USM 2004

Ogos 2004 - Persatuan MIMATES dengan 20 orang anggotanya telah berjaya membuat pameran semasa majlis konvokesyen USM 2004 berlangsung yang antara lain bertujuan memperkenalkan Pusat Pengajian Kejuruteraan Bahan Dan Sumber Mineral (PPKBSM) kepada masyarakat umum. Tempat pameran yang disertai oleh keseluruhan pusat pengajian ini telah diadakan di dewan kulian X dan berhampiran dengan tapak konvokesyen. Keseluruhan mereka yang terlibat dalam pameran ini adalah terdiri daripada pelajar-pelajar di semua peringkat tahun pengajian dan diketuai oleh pengarah projek Mohd Rohaidi Yusof, pelajar tahun tiga kejuruteraan bahan. Semasa pemeran ini berlangsung sambutan orang ramai terhadap pameran pusat pengajian PPKBSM amat menggalakkan. Persatuan ini juga telah berjaya memperkenalkan tujuan pusat pengajian ini ditubuhkan termasuk bidang kerjaya yang boleh diperolehi bagi seseorang graduan daripada pusat pengajian ini. Antara bahan-bahan pameran yang turut diperkenalkan termasuklah penggunaan alat-alat letupan (blasting), produk-produk simen dan mineral yang terdapat di Malaysia, bahan-bahan seramik, barangan polimer, mesin pengaduk bahan polimer dan lain-lain barangan berkaitan pusat pengajian ini. Para pengunjung turut diberikan cenderahati sebagai kenang-kenangan daripada pusat pengajian. Bagi pihak pusat pengajian, pameran ini amat penting dan bermakna dalam usaha memperluaskan lagi martabat pusat pengajian dan USM sendiri.

Lawatan Prof. Mutoh daripada Universiti Nagaoka

Oktober 2004 - Pusat pengajian berbesar hati menerima kunjungan daripada Prof Mutoh dari Universiti Nagaoka pada 23 Oktober 2004. Lawatan beliau adalah untuk membentangkan secara umum berkenaan penyelidikan yang dilakukan di makmal beliau dan berbincang mengenai topik penyelidikan yang boleh dilakukan secara usahsama antara pusat pengajian dan Universiti Nagaoka.

Agenda utama lawatan beliau adalah untuk membincangkan penubuhan 'Centre of Excellence COE workshop' bagi kejuruteraan bahan dalam aspek pendidikan dan penyelidikan yang akan diadakan pada Ogos 2005 di mana PPKBSM telah dipilih sebagai penganjur bersama dengan Universiti Nagaoka untuk bengkel COE yang ketiga yang akan diadakan di Pulau Pinang. Semoga kerjasama ini akan membawa manfaat kepada pusat pengajian dan usahasama ini akan berterusan pada masa akan datang.

Pameran Poster Latihan Industri

Julai 2004 - Seramai 123 pelajar tahun 3 daripada kejuruteraan bahan dan sumber mineral yang menamatkan latihan industri selama 10 minggu telah mengadakan poster latihan industri pada 7 Julai 04 di dewan utama, kampus Kejuruteraan. Acara ini merupakan acara tahunan pusat pengajian bagi memberikan pendedahan kepada pelajar tahun 3 untuk berkongsi input yang diperolehi sepanjang tempoh latihan industri bersama pelajar yang lain.

Pameran poster latihan industri ini mewajibkan semua pelajar memberi menerangan dalam bahasa inggeris dan setiap pelajar dinilai oleh pensyarah yang terlibat. Untuk aktiviti ini, semua pensyarah adalah terlibat dalam menemuramah peserta dan menilai setiap poster yang dipamerkan dan sesi soal jawab yang diadakan. Acara kemuncak sepanjang pameran poster ini adalah penganugerahan bagi 10 poster terbaik. Pada kali ini poster terbaik dimenangi oleh saudari Tee De In daripada kejuruteraan bahan yang menjalankan latihan industri di syarikat Philips Semiconductor. Syabas dan tahniah kepada semua pelajar yang terlibat dan jutaan terima kasih kepada semua pensyarah yang turun padang memeriahkan pameran poster ini.

Upacara Konvokesyen USM ke-33

Ogos 2004 - Pada upacara konvokesyen USM ke-33, seramai 35 graduan ijazah tinggi dan 148 graduan prasiswazah telah berjaya berijazah daripada PPKBSM. Pada konvokesyen kali ini, USM mengeluarkan lebih daripada 1,000 orang graduan ijazah tinggi dan seramai 6,355 orang menerima ijazah masing-masing dalam sembilan Sidang Konvokesyen. Sidang Pertama yang berlangsung pada 4 Ogos 2004, jam 9.00 pagi dipengerusikan oleh Canselor, Seri Paduka Baginda Raja Permaisuri Agong Tuanku Fauziah binti Al-Marhum Tengku Abdul Rashid. Pada sidang ini Naib Canselor USM itu telah mengumumkan bahawa Tun Dr. Mahathir Mohamad, 79, negarawan ulung yang memegang tampuk pemerintahan negara selama 22 tahun merupakan penerima tunggal ijazah kehormat USM pada tahun ini. USM menganugerahkan Ijazah Kehormat Tertinggi Doktor Sains kepada beliau sebagai mengenangkan jasa dan sumbangan beliau dalam mempromosikan Sains dan Teknologi bukan sahaja di dalam negara malah ke seluruh dunia.

PPKBSM pada upacara konvokesyen ini telah berjaya mengeluarkan 3 graduan doktor falsafah iaitu Dr Chow Wen Syang, Dr Razaina Mat Taib dan Dr Zulkifli Mohamad Ariff yang kini menjadi tenaga pengajar di pusat pengajian, 18 graduan sarjana sains melalui mod penyelidikan dan 14 garduan sarjana sains melalui mod campuran. PPKBSM juga telah berjaya mengeluarkan 93 graduan sarjana kejuruteraan bahan dan 55 graduan sarjana kejuruteraan sumber mineral. Diharapkan graduan-graduan yang dilahirkan oleh pusat pengajian mampu bersaing di peringkat global dalam bidang pengkhususan masing-masing. Syabas dan tahniah kepada semua graduan PPKBSM daripada warga PPKBSM. Semoga hubungan erat antara graduan yang telah dilahirkan dan pusat pengajian akan dapat diteruskan melalui

High Temperature Cuprate Superconductor on NiO/Ni Substrate

Zainovia Lockman and J. L. MacManus Driscoll[1]

[1]*Department of Materials and Metallurgy, University of Cambridge, Pembroke Street, Cambridge, CB2 2QZ, UK*

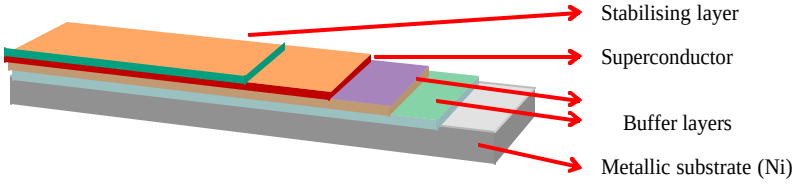
High temperature superconductor (HTS) based on cuprate compounds (for example $YBa_2Cu_3O_{6+x}$ (YBCO)) are well known to have excellent superconducting properties which has driven significant amount of research in this area since the discovery in 1986. The advancement in this field is technologically centered and applications driven and up to date there have been several state of the art superconducting devices and components that have successfully been fabricated. An idealised main application for superconductors is of course to employ them in the transmission of commercial power to cities as resistanceless wire could save a lot of energy in delivering electrical powers to consumers. Indeed, it has been realised even though long length production is still yet to be materialised. For example in May of 2001 some 150,000 residents of Copenhagen, Denmark, began receiving their electricity through HTS material. The HTS cable was only 30 meters long, but proved adequate for testing purposes [1]. However, since HTS is really a low temperature phenomenon (despite the name), a reliable cryogenic system is required. Therefore, the savings in electrical losses could compensate the investment for the added complexity due to cooling to very low temperature (liquid nitrogen boiling point, 77K is often used). Moreover, as mentioned, the cable industries have limited success in producing long length superconductor cable due to the difficulties in the fabrication process. This however does not despair the industries involved in HTS projects in finding other potential applications of superconductors for example by manipulating the capability of this material to repel magnetic field. A spectacular application of this phenomenon is the magnetic levitating train (Maglev). The Maglev train with speed up to 450km/hour has begun its operation in Shanghai, China in January 2004. This has been one of the major breakthroughs in the application field of superconductor materials. The movement of resistance-less electron in a superconductor loop has created currents of unprecedented intensities (millions thousand ampere/cm^2), which in turn generated exceptionally intense magnetic fields. Applications such as Magnetic Resonance Imaging (MRI) has utilised the capability of the 'supermagnet'. This device has now been widely used in hospitals.

Other equipments for the power industry, like transformers, generators and motors are now perfected to produce useful consumer (civilian but mostly military) products. These products often have specific applications like ship propulsion, microwave generator, e-bomb and magnetic field sensor (using superconducting quantum interference device (SQUID)) [1]. However, HTS compounds still present a particularly challenging set of properties that makes the realisation and reproducibility of high quality product is somehow problematic. Being ceramic, HTS is brittle hence thin film on flexible metallic substrate is preferred and the cuprate oxides display anisotropic conducting, meaning that the production of the superelectrons occurs only along the CuO_2 planes (a-b axes). For this reason, the crystallographic alignment of the crystals is the prerequisite in developing useful HTS devices. Therefore despite of all of the fantastic applications, the exploration to the fabrication process of HTS ceramic superconductor still remain active.

From late 1990s until now, research focus has been given to the fabrication processes of thin film YBCO which is a second generation conductor that has excellent current carrying performance even when exposed to high magnetic fields and high temperatures, unlike the first generation HTS in particular the Bi-based compounds [2] [3]. However one main problem is the must to grow biaxially oriented YBCO grains so that high critical current density (JC) can be conducted inter and intra grain without any loss [2]. To circumvent the problem, YBCO is often grown on a textured substrate. The substrate acts as a template layer for the epitaxial growth of the superconducting film. The best YBCO film grown to date as determined by the measure of the JC is epitaxially grown on series of textured buffer layer on a so called rolling-assisted-biaxially-textured substrate (RABiTS), (100)<001> Ni and Ni-alloys [4]. These multi layered system is termed coated conductor and have ever since been accepted as a standard industrial configuration for making superconductor power devices. A typical architecture normally with configuration of $Ni/CeO_2/YSZ/CeO_2/YBCO/Ag$ is shown in Figure 1. The need of the buffer layer is mainly to prevent chemical reaction between YBCO with Ni as Ni can poison YBCO lowering down the JC. Various oxides with similar lattice parameters with YBCO have been chosen for buffer layer material for example CeO-, yttrium stabilized ZrO (YSZ) and MgO.

One problem with the Ni RABiTS substrate is that Ni is prone to oxidation especially during the deposition process of the buffer layer. Precipitates of NiO formed at high temperature which often impede the epitaxial growth of the buffer layer material on this substrate. To avoid this, buffer layer deposition is done in ultra high vacuum chamber like the pulsed laser deposition (PLD) system, which is well known for being costly and complex. Simplification of the substrate-buffer layer architecture is crucial for higher speed production. One approach for simplification is first to develop a textured protective layer using the native oxide (NiO) on Ni substrate by a control oxidation process [5,6]. Once NiO is produced, a protected, more versatile substrate is made for further deposition of buffer layer. A larger processing window for the buffer layer deposition is then possible and a more expensive vacuum apparatus would not be needed. In developing this versatile NiO/Ni buffer-substrate configuration, it is useful to thoroughly investigate the oxidation behaviour of Ni and Ni-alloys in order to form high quality oxide. Oxidation of Ni has been studied excessively for the past 100 years but the development of smooth, crack-free and most importantly epitaxial layer on a textured polycrystalline Ni is still in its early days. Since the NiO is to be used as the buffer layer, the crystallographic orientation of NiO is crucial. Only (100)<001> (cube oriented) NiO is allowed to form on the substrate.

The formation of textured NiO on RABiTS via thermal oxidation has been termed surface oxidation epitaxy (SOE). The term was coined by the pioneer of the process; Matsumoto et al [7] from International Superconductivity Technology Centre (ISTEC) Laboratories, Japan in 1998. In late 1990s and in the beginning of the new millennium, the



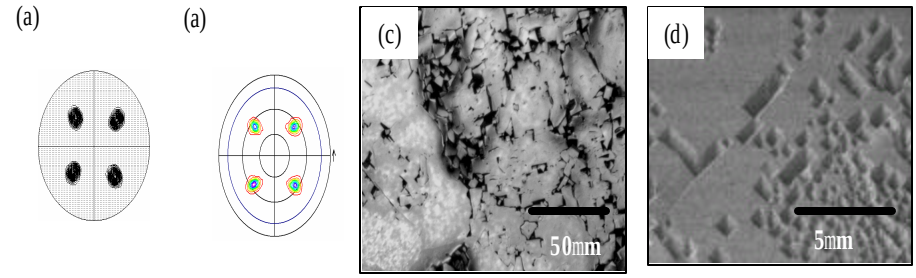


Figure 2. (a) (111) Ni EBSD pole figure for the as-made Ni RABiTS (b) (111) NiO x-ray pole figure of the optimum NiO layer and (c) the surface microstructure of the optimum oxide (low magnification, optical microscope) and (d) higher magnification image of the surface microstructure (FIB).

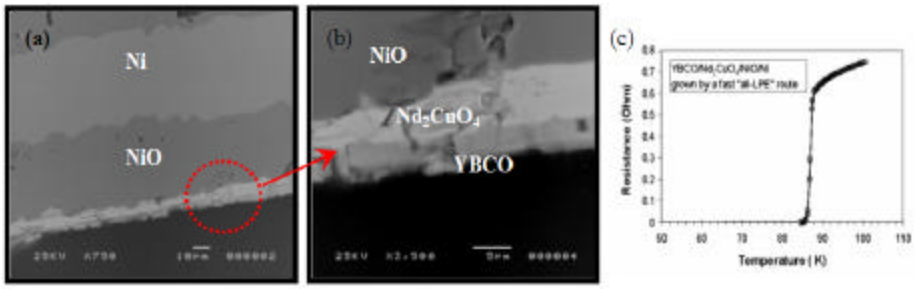


Figure 3. Cross section of LPE YBCO on Nd_2CuO_2/SOE NiO/Ni (a) General view and (b)higher magnification image and (c) is the resistance versus temperature plot showing TC ~ 90K

quest for optimum condition for NiO growth had been very active with several research groups across the world actively involve in the SOE process. One successful work was the work done at Imperial College London, where Lockman et al has shown that the optimum temperature for the production of cube textured NiO on pure Ni oxidation is +/- 1250^{O}C in flowing oxygen [6]. Detailed study of the oxidation process of Ni was being carried out with a conclusion that under certain oxidation conditions, it is possible to obtain cube oriented NiO on pure Ni [5,6]. Representative of the texture data are shown in figure 2 (a) and (b). (a) shows the (111) Ni pole figure using electron backscattered diffraction (EBSD) before oxidation and (b) is x-ray (111) NiO pole figure of the as-oxidised Ni (oxidation at 1250^{O}C in O_2). The four poles of both samples indicate cubic type structure hence NiO grown epitaxialy on Ni. A representative surface morphology of the oxide is shown in figure 2 (c) for lower magnification (optical microscope, OM) and 2 (d) for higher magnification (focus ion beam microscope (FIB)). Lower magnification image shows the surface oxide contains region of flat squares grains supporting the crystallographic orientation of (100) type grains. In (d) the flat regions were focused, to show the regions contain micron-sized square pits which might form due to the lateral growth of the (100) NiO.

In the same laboratory, the high temperature superconductor group at reported the deposition of a buffer layer of Nd_2CuO_4 (NCO) via a non-vacuum process of liquid phase epitaxy (LPE) method [8] [9] on these protected Ni substrate. The YBCO was also coated on the system to give decent superconducting values (see figure 3 for the cross section images of the multi-layer configuration and the resistivity value of the YBCO made on Ni/NiO/Nd_2CuO_2 substrate system). This shows that non-vacuum system is possible for HTS production provided NiO/Ni is first produced.

Even though the prospect of making devices out of the second generation, YBCO HTS has shown rewarding success, the quest of finding a route where superconductor can be made cheaper and easier remains active. In this short article we have summarised one of the possible route in making useful superconductor device. This is achieved by SOE of the Ni substrate coupled with LPE process to deposit buffer later and the HTS film. It is our hope that more research works could be carried out on these materials as superconductivity, without a doubt, is one of the most outstanding discoveries in the world of materials science. Who could imagine before 1986 that a ceramic can conduct current with zero resistance?

References

[1] www.superconductors.org
[2] J. L. MacManus-Driscoll, Annual Review Materials Science, vol. 28, (1998), pp. 421-462
[3] D. K. Finnemore, K. E. Gray, M.P. Kroger, Physica C, vol. 320, (1999), pp. 1-8
[4] ORNL superconducting Technology Programme for Electric Power System Annual Report FY 2000 and FY2002, http://www.ornl.gov/HTSC
[5] Z Lockman, Surface Oxidation Epitaxy of Ni and Ni-alloys, Doctor of Philosophy Thesis, Imperial College London, 2003
[6] Z. Lockman, X. Qi, A. Berenov, W. Goldacker, R. Nast, B. deBoer, B. Holzapfel and J. L. MacManus-Driscoll, Journal of Materials Research, vol. 18, no. 2, (2002), pp. 327-337
[7] K. Matsumoto, S-B Kim, I. Hirabayashi, T. Watanabe, N.Uno and M. Ikeda, New Fabrication Methods of high JC YBCO Superconducting Films on Flexible Metallic Substrate, in Proceedings of Advance in Superconductivity X, K. Osamura and I. Hirabayashi, Eds. Tokyo, Springer, Verlag, (1998), pp. 611-614
[8] X. Qi, M. Soorie, Z. Lockman, J. L. MacManus-Driscoll, Journal of Materials Research, (2002), vol. 17, no. 1, pp.104
[9] X. Qi, M. Soorie, Z. Lockman and J. L. MacManus-Driscoll, Physica C, vol. 372-376, part 2, (2002), pp. 742-746

Solid State Nickel Metal Hydride battery

Ahmad Azmin Mohamad and A.K. Arof[1]
[1]*Physics Department, University of Malaya, 50603 Kuala Lumpur.*

Introduction

Nickel metal hydride (Ni-MH) batteries have become popular as a power source for portable electronic equipments such as computers, cellular phones and electric shavers. The capacity of a Ni-MH battery, approximately twice that of a standard nickel-cadmium battery mainly relies on the characteristics of the hydrogen-absorbing alloy used for the battery's negative electrode.

Mg2Ni alloy is one of the promising materials to be used as negative electrode in Ni-MH battery [1]. The Theoretical discharge capacity of Mg_2Ni (999 mA hg-1), evaluated from the amount of absorbed hydrogen, is much greater than that of $LaNi_5$ and ZrV_2, which are conventional AB5 and AB2-type hydrogen storage alloys, respectively [2,3]. However, Mg_2Ni alloy is easily oxidized, especially when it comes into contact with highly corrosive electrolyte. Deterioration of electrode performance due to corrosion of electrode components is a critical problem. This surface oxide layer is believed to inhibit the hydriding-dehydriding reaction on the electrode, resulting in the capacity decay [4,5]. To overcome

electrolyte can be utilized to replace the conventional potassium hydroxide (KOH) aqueous electrolyte used in Ni-MH batteries.

In this work, the applicability of polymer electrolyte based on polyvinyl alcohol (PVA) as solid electrolyte in Ni-MH cell was studied. The polymer film was prepared by the solution casting technique using potassium hydroxide as the dopant and water as the solvent. The cyclability of Ni-MH battery employing this polymer film with Mg_2Ni as negative electrode and $Ni(OH)_2$ as positive electrode was also studied.

2 Ni-MH Chemistry (M = Mg_2Ni)

For a Ni-MH battery using $Ni(OH)_2$ as the cathode, Mg_2Ni-based hydrogen storage alloy as the anode and KOH as the electrolyte, the charge-discharge reaction can be summarized as follows:

- at the positive (cathode) electrode:

$$Ni(OH)_2 + OH^- \leftrightarrow NiOOH + H_2O + e^-$$

-at the negative (anode) electrode:

$$4Ni(OH)_2 + Mg_2Ni \leftrightarrow 4NiOOH + Mg_2NiH_4$$

- at overall cell reaction:

$$Mg_2Ni + 4H_2O + 4e^- \leftrightarrow Mg_2NiH_4 + 4OH^-$$

Thus, $Ni(OH)_2$ is oxidized to NiOOH at the positive electrode during charging. Hydrogen which is formed at the surface of the negative electrode subsequently diffuses into the bulk of the Mg_2Ni alloy to form Mg_2NiH_4. The reaction proceeds in the opposite direction during discharge.

The process of charging-discharging of these batteries involves the insertion of ions into both positive and negative electrodes. In Ni-MH batteries, the hydrogen ion shuttles between the positive and the negative electrode, as lithium ions in lithium batteries.

3.0 Experimental

3.1 Materials Preparation

3.1.1 Preparation and characterization of polymer electrolyte

PVA with Mw of 67000, KOH and dionized water were used as starting materials for ASPE preparation. The film was prepared by dissolving 1 g PVA in 10 ml deionized water. Different weight percentage of KOH was dissolved in 10 ml of water in a different beaker. The two solutions were then mixed and poured into petri dishes and left for slow drying to form films. For films were then placed in a dessicator for about a month for further drying.

The electrical conductivity of the polymer films was measured at room temperature using a computer-interfaced HIOKI 3531-01 LCR bridge in a frequency range from 42 Hz to 5 MHz

3.1.2 Preparation of electrode materials

In this study, Mg_2Ni alloy powders were synthesised by mechanical alloying. The starting materials, pure Mg powders (99.9% purity) and Ni powders (99.9% purity) were mixed and placed in a hardened steel vessel with stainless steel balls of 20.0 mm diameter. Mechanical alloying was carried out with a ball to powder ratio of 15:1, using a PASCAL 9VS ball mill for 20 days at a milling speed of 200 rpm. This material was later used as the active material of negative electrode for battery fabrication.

The negative electrode was prepared by mixing Mg_2Ni alloy powder with graphite powder in a weight ratio 5:1. 10% PVA solution was used as binding agent. This mixture was then pressed onto nickel-wire mesh.

For the positive electrode, $Ni(OH)_2$ and 10% PVA solution were used as the active material and binder respectively. $Ni(OH)_2$ was mixed with 10% PVA solution which and then pressed onto nickel-wire mesh.

3.2 Battery design and assembly

The battery was constructed by using a prismatic design, see Figure 1. The battery was prepared by assembling a square-shaped metal hydride electrode (thickness: 1.00 mm, surface area: 15 cm_2) and a square-shaped nickel electrode (thickness: 0.60 mm, surface area: 15 cm_2), and solid polymer electrolyte film (thickness: 0.004 mm) in middle. The assembly was put in a moisture proof casing, hot pressed and then sealed.

The conductivity measurements were performed with a HIOKI 3531 LCR bridge that had been interfaced with a computer in the frequency range 50 Hz-1 MHz. A BAS LG-50 Galvanostat was used to perform constant-current charge and discharge of the battery.

4.0 Results and discussion

Fig. 2 shows the variation of conductivity with the KOH content in the PVA based polymer films. The highest conductivity, in the order of 10-4 S cm^{-1}, was achieved upon addition of 40-wt% KOH to PVA. This film was used in the fabrication of battery with the configuration $Ni(OH)_2$/polymer electrolyte/Mg_2Ni. The battery was charged at current of 10.0 mA for 1 h and discharged at 0.1 mA. The charge-discharge characteristics of the battery are shown in Fig. 3. The plateau potential of the battery is about 1.3 V and seems to be constant for about 9.5 hours for the 7th cycle. However large drop of voltage was observed after 7th cycle. This may be due to large interfacial resistance between the electrodes and the electrolyte [6-10].

5.0 Conclusion

An all-solid state Ni-MH battery has been successfully developed using PVA based solid polymer electrolyte and Mg2Ni and Ni(OH)2 as negative and positive electrode, respectively. Work is still being carried out to improve the performance of this type of battery.

6.0 References

1. Lei Y.Q., Wu Y.M., Yang Q.M., Wu J. and Wang Q.D., Z. Phys. Chem, 183 (1994) 379.
2. Lou J.L. and Cui N., J. Alloys Comp., 264 (1998) 299.
3. Wang C.Y., Yao P., Bradhurst D.H., Liu H.K. and Dou S.X. J. Alloys Comp., 285 (1999) 267.
4. Reilly J.J., Adzic G.D., Johnson J.R., Vogt T., Mukerjee S. and McBreen J., J. Alloys Comp, 293-295 (1999) 569.
5. Cui N., He P. and Lou J.L., Electrochimica Acta, 44 (1999) 3549.
6. Vassal N., Salmon E. and Fauvarque J.F., J. Electrochem Soc., 146 (1999) 20.
7. Vassal N., Salmon E. and Fauvarque J.F., Electrochimica Acta 45 (2000) 1527.
8. Fauvarque J.F., Guinot S., Bouzir N., Salmon E. and Penneneau J. F. Electrochimica Acta, 40 (1995) 2449.
9. Guinot S., Salmon E., Penneneau J. F. and Fauvarque J.F., Electrochimica Acta, 43 (1998) 1163.
10. Kuriyama N., Sakai T., Miyamura H., Kato A. and Ishikawa H., J. Electrochem Soc., 137 (1990) 355.

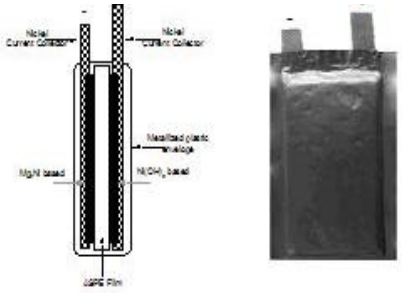


Fig. 1: A schematic diagram of basic construction and assembled of solid state Ni-MH cell.

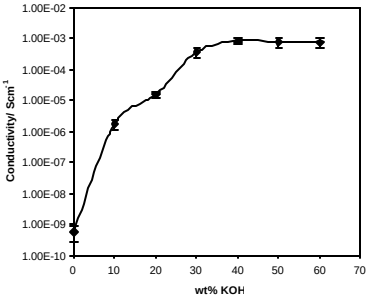


Fig. 2. Variation of conductivity with KOH weight percentage

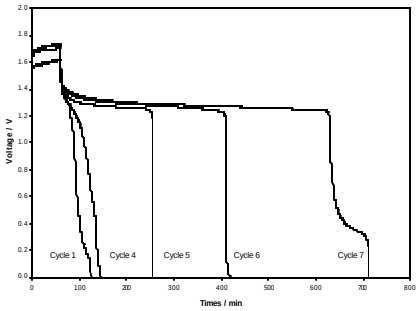


Fig.3.Charge-discharge characteristics $Mg_2Ni/PVA+KOH/Ni(OH)_2$ electrochemical cells.

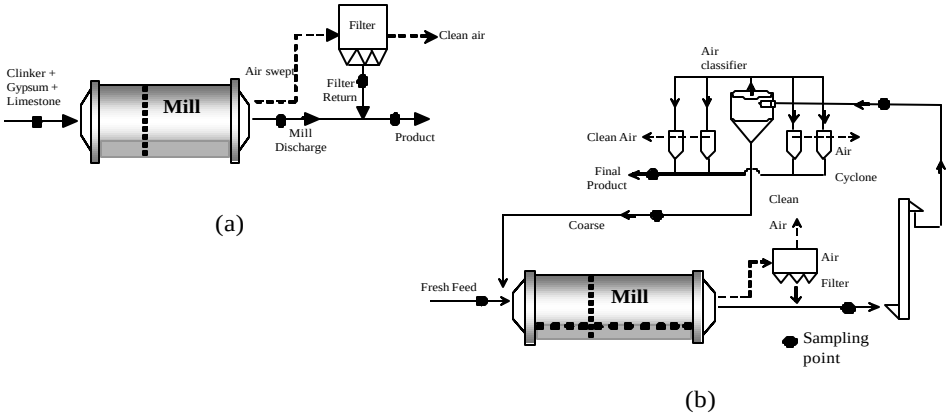


Figure 1: Typical cement grinding in (a) open circuit and (b) close circuit

Mathematical Modelling and Simulation of Mineral Processing Processes

Syed Fuad Saiyid Hashim, Khairun Azizi Mohd Azizli, Hashim Hussin, Samayamutthirian Palaniandy
mrsyfuad@eng.usm.my

Introduction

Comminution is the most energy intensive operation in many industrialised countries. In mineral processing operations, comminution consumed more than 50% of the power consumption in a plant (Austin, 1984). It is considered to be an inefficient process from the point of view of energy utilisation and researchers have been trying for many decades to develop accurate process models that can be used to assist in achieving optimum energy utilization with substantial economic benefits. This include the production of finer particles that has become very important especially in the field of cement manufacturing, industrial minerals and high-tech ceramics.

Computer simulation is now becoming a very powerful tool in the design and optimization of mineral processing plants. Simulation technique allow the engineers and metallurgists to better control their plants with the optimum operating conditions. The great power of simulation as optimization, and indeed design, tool is its ability to explore many different scenarios quickly and efficiently. The technology was well implemented in dry and wet grinding circuit and has brought large economic benefit.

Computer simulation is intimately associated with mathematical modelling and realistic simulation relies heavily on the availability of accurate and physical meaningful models. A model is an equation, or set of equations, that relates responses (independent variables) of interest to controllable independent variables. Models have not been widely used for mineral circuit design and optimization purposes, even though they have been discussed at length in the technical literature for the past 30 years. This may be due to doubts about the accuracies of the models (inaccuracies in models can give ridiculous result) and the reticence of design engineers to use new and unfamiliar techniques. However the accuracy with which size reduction and size separation units can be modelled has advanced rapidly in recent years and simulation is now proven and accurate technique for the design of circuit as well as optimization of circuits containing crushing and grinding circuits. The simulation procedure will followed on a step-by-step basis. This may seem to make simulation appear to be long and labored procedure but in fact the procedure is ideal for the use of computer based interactive graphic programs. The use of simulation for optimization will be discussed in this paper by considering a specific problem, the optimization of cement grinding circuits (Figure 1).

Optimization of Cement Grinding Circuits Using Simulation

Two-Compartment Ball Mill and Separator Models

a) Ball mill Model

The perfect mixing ball mill model developed by Whiten (1976) has been used widely in ball mill modelling. The model considers the mill to be perfectly mixed. The process can be described in terms of transport through the mill and breakage within the mill. As the mill is perfectly mixed, the mill content is related to mill product with discharge rate, di, for each size fraction.

$$p_i = d_i s_i \qquad (1)$$

The balance equation around each size fraction at steady state is

$$f_i + \sum_{j=1}^{i} a_{ij} r_j s_j - p_i - r_i s_i = 0 \qquad (2)$$

where

fi-is the mass flow rate of size fraction i in the mill feed

ri-is the specific breakage rate of size fraction i

aij-is the mass fraction of the size j that appear in size i after break

di-is the specific discharge rate of size fraction i

pi-is the mass flow rate of size fraction i in mill discharge product

substitute the mill contents, si

$$f_i + \sum_{j=1}^{i} [\frac{a_{ij} r_j p_j}{d_j}] = p_i + \frac{r_i p_i}{d_i} \qquad (3)$$

Calibrating the model to a ball mill involves the calculation of r/d for each size fraction from a set of actual feed and product measurements, subjected to a reasonable form of the breakage distribution function (Napier-Munn et al, 1996)

b) Diaphragm and Air Separator model

The efficiency curve developed by Lynch et al (1977) is used to model the diaphragm and the air separator. There are three parameters in the model:

C - the proportion of particles subjected to the classifying effect

α - a model parameter defining the sharpness of classification

d50c- the corrected cut size

$$E_{OF} = C\left[\frac{\left(1 + b \cdot b^* \cdot x\right)\cdot\left(e^a - 1\right)}{e^{\left(a \cdot b^* \cdot x\right)} + e^a - 2}\right] \qquad (4)$$

where,

EOF = fraction of feed to overflow

C = fraction of material subjected to real classification (bypass = 1-C)

a = reduced efficiency curve sharpness parameter

b = reduced efficiency curves fish hook parameter

b^* = parameter to preserve the definition d50C, ie d =d50C when E=(1/2)C

x = d/d50C

d = size

d50C = size of a particle in feed which has equal probability of going to underflow or

overflow

Calibration of efficiency curve model involves the calculation of best-fit values of the parameters describing the efficiency curve, i.e. d50c, , C and if required.

Data Evaluation, Modelling and Simulation Studies

It could be seen from the size distribution for all surveys that the size distribution inside the mill became finer along the mill to the middle diaphragm (Figure 2 (a)). It became slightly coarser just before the grate, indicated by Points 3 and 4. The slight change in size distribution believed to be due to material that was not fine enough to pass through the grate were 'thrown back' or recycled for further grinding. For the second compartment, the same trends were observed.

From the result, the first compartment was modelled as two perfectly mixed ball mills in series, the last one being close circuited by a screen. The second compartment can be modelled by one perfectly mixed ball mill only, as described by Benzer (2000).

Calibration or model fitting of models was then done to obtain the correct parameters. For modelling studies of the two compartment ball mill, calculation of r/d values was necessary (refer equation 3). The breakage distribution function for clinker was determined using drop weight testers (Napier-Munn et al, 1996, Benzer et al, 2001). The calibration of the ball mill models were carried out by calculating the best fit values of r/d function in equation 3, using feed and product size distributions and experimentally determined breakage distribution function. Calibrated models shows very good fit to the measured size distribution samples taken around and inside the mill (Figure 2(b))

Meanwhile, model fitting process for diaphragm and air separator involved the calculation of best fit values for the parameters describing the efficiency curve (Napier-Munn et al, 1996; Benzer, 2001). Results from this exercise also indicate a good outcome (Figure 4). All

Table 1: The calibrated model parameters for the closed circuit mill

	First Compartment		Middle Grate (Diaphragm)		Second Compartment	
	Ball Mill 1	Ball Mill 2			Ball Mill 3	
Size (mm)	Ln (R/D)	Ln (R/D)			Size (mm)	Ln (R/D)
0.04	-1.75	-2.67	C	100	0.04	-1
0.1	-0.03552	-1.27	α	10	0.09	-0.009
2	2.61	3.23	β	1	0.3	2.5
15	4.76	2.78	d_{50c}	0.8295	5	3

Air Separator	
C	88
α	5
β	0.0005
d_{50c}	0.045

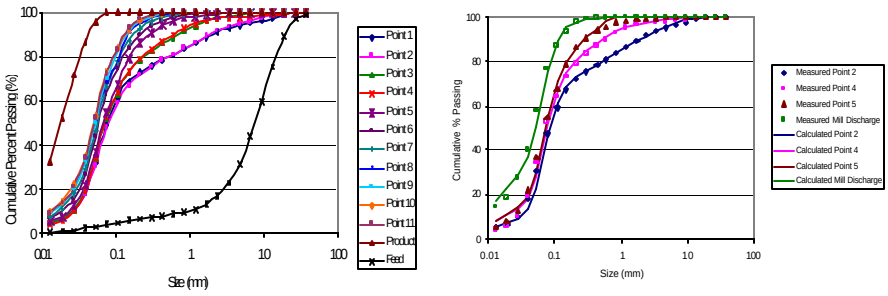
calibrated model parameters are shown in Table 1. By using the model parameters given in Table 1 and adjusting them as necessary, the size distribution of the circuit product was simulated for different condition and the results were compared with the measured data. Simulation test condition are shown in Table 2. Figure 3 and 4 show the calculated and measured product size distribution for both simulation conditions. It could be seen

Table 2: Fitted and simulated condition for close circuit

Operating Conditions	**Fitted Condition**	**Simulation 1**	**Simulation 2***
Feed Rates (TPH)	91	115.5	105.1
Feed size distribution (% Passing –6.7mm)	43.99	47.17	57.16
Work Index (kWh/ton)	17.6	18.2	17.9

* smaller ball size in the second compartment

that the difference between measured and calculated values were very small and within acceptable limits. This means that the modelling approach can be a useful quantitative indication of what may occur in clinker grinding mills. It is possible therefore to study other operating conditions such as ball size, mill load and other circuit configurations.



(a) (b)

Figure 2: (a) Size distribution along the mill axes for both compartment for close circuit
(b) Measured and calculated size distribution after model fitting/calibration

Conclusion

Simulation is an important design tool which is widely used in many branches of engineering. It has been late in coming to mineral processing mainly because of the difficulties in defining particle characteristics and process behaviour. Examples used in modelling and simulation of cement grinding circuit was found to give successful results. The perfect mixing ball mill model and efficiency curves model can accurately describe the mill and air separator.

References

1) Austin, L.G., Klimpel,R.R., Luckie,P.T., 1984. Process Engineering of Size Reduction : Ball Milling. Society of Mining Engineers, New York, 561 pp.

2) Benzer, H., 2000. Mathematical Modelling of Clinker Grinding Process. PhD Thesis,
University Of Hacettepe, Turkey.

3) Benzer,H., Ergun,L.,Oner,M. and Lynch,A.J., 2001. Simulation of open circuit clinker
grinding. Mineral Engineering, Vol 14, No 7, pp 701-710

4) Syed F.S.Hashim, 2004 Mathematical modelling of the two-compartment mill and classification. PhD Thesis. University of Queensland

5) Zhang, Y., 1992. Simulation of Comminution and Classiffication in Cement Manufacture. PhD Thesis, University of Queensland.

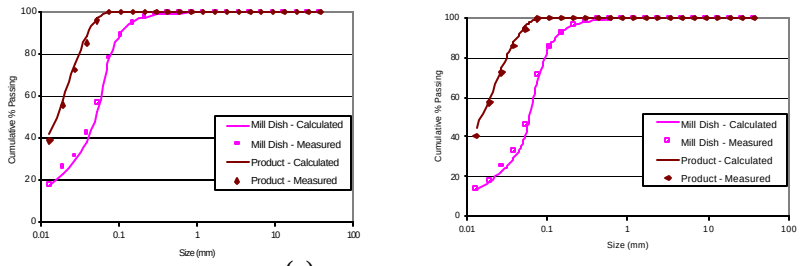


Figure 3: Measured and calculated size distribution for close circuit. (a) simulation condition 1 and (b) condition 2)

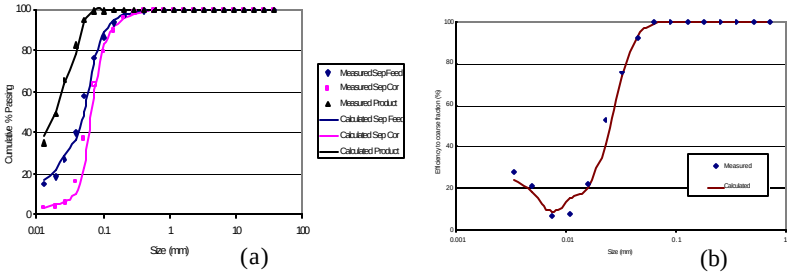


Figure 4: (a) Measured and calculated size distribution around the air separator (b) measured and calculated efficiency curve

Grinding Circuits, Their Simulation, Optimization, Design and Control, Elsevier Scientific Pub. Co.., Amsterdam 340p

7) Napier-Munn, T.J., Morrell,S., Morrison,R.D., Kojovic,T., 1996. Mineral Comminution Circuit - Their Operation and Optimisation. Julius Kruttschnitt Mineral Research Centre, Brisbane, p 413

Foaming Behaviour Dependence on Formulation of Cross Linked Low Density Polyethylene Foams

Zulkifli M. Ariff and Geoffrey L. A. Sims[1]

[1]*Manchester Materials Science Centre University of Manchester and UMIST Manchester, United Kingdom*

INTRODUCTION

Cross linked polyethylene foams have been of significant commercial interest since the 1970's. Processing techniques and formulations have been developed to manufacture products that have excellent physical and mechanical properties [1]. Foam properties are usually dependent on density, the mechanical properties of the base polymer and cellular structure which include cell size, membrane thickness, cell shape and open cell content. Although density has been investigate more thoroughly than other parameters [2], cell size also plays an important role on properties of cellular polymers. controlled by various parameters such as type of base polymer, blowing agent concentration, cross linking level and processing conditions, which affect the crystallinity, molecular orientation and rheological properties of the polymer phase [3]. This paper presents a study on LDPE foams produced by conventional two stage heat and chill technique investigating interrelationship of cross linking and blowing agent concentrations on densities, gel content and crystallinities. These are discussed in relation to the properties of resultant cellular materials.

EXPERIMENTAL

Raw materials

Low density polyethylene (LDPE), Stamylan 1908 manufactured by DSM was used as the base ploymer. This is a standard high pressure LDPE grade of density 920 kg/m3 and melt index of 7.5 dg min-1 at 190^{o}C. Cross linking was affected by PERKADOX BC 40K (40% dicumyl peroxide (DCP) on an inert clay carrier) manufactured by AKZO Chemicals. The chemical blowing agent (BA) selected was a commercially available system for two stage compression moulding, DP45/1, based on activated azodicarbonamide (ADC) manufactured by Schering Polymer Additives (subsequently Bayer AG).

Foam production

A variety of foam densities were produced containing 8 and 15 parts per hundred amount (1.0 phr) of DCP. Foams were also produced by incorporating 0.5 to 2.0 phr of dicurnyl peroxide with a constant level of blowing agent (8 phr) to assess varying levels of cross-linking.

Foams were prepared using two stage compression moulding technique as follows. Initial mixing of the formulation components was carried out on an electrically heated two roll mill with maximum roll temperatures of 115^{o}C to minimise premature cross linking. To further protect against initiation of cross-linking on the mill, the procedure involved thorough mixing of the polymer and blowing agent prior to the addition of peroxide. After a short but adequate cutting and folding time to mix in the peroxide, the matrix was taken off the mill and stored at room temperature for approximately 24 hours. 80 grams of matrix (equivalent to approximately 103% of the mould volume) was placed in to a preheated mould at 165^{o}C for 20 minutes at 14000 kPa. During this period of time, complete cross linking and blowing agent decomposition took place. The pressure was then maintained whilst cooling the mould down to 40^{o}C (approximately 4 minutes). Following pressure release, the partial expanded moulding was immediately placed in a circulating hot oven at a predetermined temperature for 20 minutes to gradually complete the expansion.

Densities and Compression Load Deflection

Densities and compression load deflection procedures were in accordance with ASTM D3575 [4]. The determination of density was made by measuring the weight and volume of regular shaped specimens (i.e. 50 x 50 x 20 mm).

Compression load deflection measurements were performed on an Instron universal testing machine fitted with a compression cage deforming the samples at a uniform rate of 10 mm/min. The stress required to produce compression strains up to 50% was determined (where compressive stress was given by the force per unit area based on the original foam cross section).

Gel content

The level of cross linking of base polymer was determined in accordance with ASTM D2765 [5]. This was quoted as gel content which was obtained from residual insoluble proportion of material after refluxing foam samples in xylene at 140^{o}C for 24 hours.

Crystallinity

Crystallinity was determined using a DuPont 2000 Thermal Analyser

differential scanning calorimeter (DSC). Degree of crystallinity was calculated by comparing the melting enthalpy with that of 100% crystalline polyethylene [6] using a value for the enthalpy of a single PE crystallite of 286.8 J/g [7] in the following manner:

$$Crystallinity\ (\%) = \frac{\Delta H_{sample}(J/g)}{286.8\,(J/g)} \times 100$$

In all cases, crystallinities were determined on samples that had undergone identical milling, compression moulding and expansion treatments.

Foam cell structure

Small samples of foam were cut with a razor blade perpendicular to the rise direction from each foam block. The sample was then mounted on a stub, gold coated and micrographs were obtained using a Phillips SEM 505 scanning electron microscope operating at a spot size of 100mm and low beam energy at an accelerating voltage of 4 kV.

RESULTS AND DISCUSSION

Table 1 shows that within experimental error, gel content for all foams tested was constant for a given DCP concentration. Comparison with gel content results obtained for unblown polymer matrix (i.e. 0 phr BA) indicated that BA concentration had no significant effect on the level of cross linking in foamed samples at fixed DCP concentration. Obviously, results display that gel content increases with increasing DCP concentration which was related to the increased cross linking efficiency due to increase in radical concentration.

Table 1: Effect of BA and DCP concentration on gel content d crvstallinitv

	Gel content / %			Crystallinity / %		
DCP concentration / phr	Blowing agent concentration			Blowing agent concentration		
	0 phr	8 phr	15 phr	0 phr	8 phr	15 phr
0.5	57.9 ± 2.8	57.3 ± 1.1	-	41.0 ± 1.5	43.6 ± 1.4	-
1.0	74.7 ± 2.4	74.2 ± 1.4	74.4 ± 13	43.7 ± 0.7	40.6 ± 1.6	43.9 ± 2.8
2.0	85.6 ± 1.5	85.1 ± 1.5	85:5 ± L5	39.5+1.0	-	-

Results also show that within experimental error, crystallinity of foams was not much affected by the increase in both BA and DCP concentration. However, results hint that crystallinity may decrease with increasing cross linking (i.e. higher DCP concentration) as has been reported by other workers [8].

Results from table 2 show that the effect of increasing BA concentration on the density of foams whilst maintaining a

Table 2: Effect of BA concentration on density and mechanical properties (compression) at a fixed DCP concentration of 1.0 phr.

Blowing agent concentration /phr	Average density / kgm^{-3}	Compression Modulus / kPa	Compressive stress at. 50% strain / kPa
8	72.7 ± 1.0	936 ± 102	180.5 ± 6.5
15	44.3 ± 0.3	332 ± 19	113.4 ± 14.2

greater the amount of the blowing agent, the greater the gas volume available which resulted in a decrease in foam density. This is also supported by the different morphology of cellular structure obtained at different blowing capability (i.e. blowing agent concentration). Nevertheless, a higher amount of BA will definitely give rise to more gas liberation and larger foam cells due to an increase in expansion or blowing capability. However, smaller cells were found in foams expanded with higher amount of BA. Figures 1 and 2 show that the cell

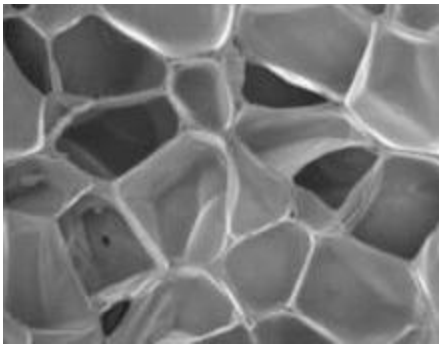


Figure 1: SEM micrograph of LDPE foam expanded at 130^{O}C (1.0 phr DCP, 8 phr BA)

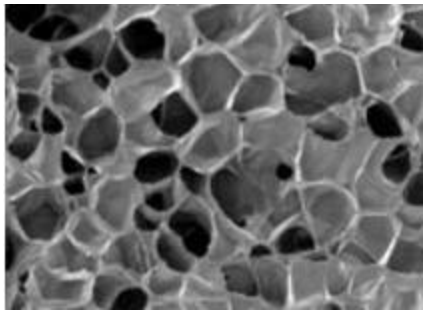


Figure 2: SEM micrograph of LDPE foam expanded at 130^{O}C (1.0 phr DCP, 15 phr BA)

size obviously decreased with increasing BA concentration. Comparison of Figures 1 and 2 indicates that at higher BA concentrations, cell nucleation is favored as a probable result of greater gas solubilisation during the cooling stage of the heat and chill process. It may also be that BA ecomposition residue provide heterogeneous nucleation sites and cell growth is dinitiated at many more locations within a specified area.This subsequently affects the mechanical properties of the foams where foams with lower density value (lower BA concentration) tend to have lower compression modulus and compressive stress at 50% strain.

Another factor that controls foam density is the cross linking level (i.e. DCP concentration). Higher level of crosslinking resulted in greater restriction to expansion, giving higher densities and superior mechanical properties (refer Table 3). These results indicate that increase in density subsequently results in higher compression modulus and compressive stress at 50% strain. Foams with higher DCP concentration have cell walls that are more restricted to extension. This was related to the melt strength results of the polymer matrix (which discussed elsewhere [9]) where

Table 3: Effect DCP concentration on density and mechanical properties (compression) at a fixed BA concentration of 8 phr. (Expansion temperature = 165^{O}C)

DCP concentration /phr	Average density / kg m-3	Compression Modulus / kPa	Compressive stress at 50% strain / kPa
0.5	69.2 ± 0.6	884 ± 197	179.9 ± 6.1
1.0	72.7 ± 1.0	936 ± 102	180.5 ± 6.5

compound with higher DCP levels have high stress levels and the melt extensibility deteriorates. This increase in expansion resistance means that bubbles cannot expand to the greatest volume and this would suggest foams with smaller cells and thicker walls as displayed by Figure 3 in comparison with Figure 1(i.e. with lower BA concentration).

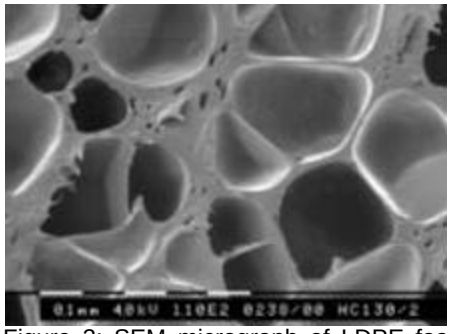


Figure 3: SEM micrograph of LDPE foam expanded at 165^{o}C (2.0 phr DCP, 8 phr BA)

CONCLUSIONS

Formulation of an expandable LDPE exhibits significant role in determining the physical and mechanical properties of the resultant foams. Increase in foam density can be achieved by either increasing cross-linking level or decreasing BA concentration. While the former step affected gel content and crystallinity, the latter had no significant effect on gel content and crystallinity. When DCP concentration is increased, gel content displays an increment while crystallinity may be reduced to some extent.

REFERENCES

1) Puri, R.R. and Collington K.T. 1988. Cell. Polym., 7, 219-231

2) Ferrigno, T. 1963. Rigid Plastic Foams, Reinhold, New York

3) Klempner D. and Frisch, K.C. 1991. Handbook of Polymeric Foams and Foam Technology, Hanser, New York

4) ASTM D3575, 1995. Standard Test methods for Flexible Cellular Materials Made From Cross-linked Ethylene Plastics, ASTM, Philadelphia

5) ASTM D2765, 1995. Standard Test Methods for Dtermination of Gel Content and Swell Ratio of Cross-linked Ethylene Plastics, ASTM, Philadelphia

6) Mears, P. 1965. Polymer Structure and Bulk Properties, Van Nostrand, London

7) Brandrup, J. and Immergut, E.M. 1984. Polymer Handbook, 3rd Edn. Wiley Interscience, New York

8) Sims, G.L.A. and Khunniteekool, C. 1996. Cell. Polym., 15, 14-29

9) Ariff, Z.M. 1998. Foaming Behaviour Dependence of Base Polymer Parameters, MSc. Dissertation, UMIST

Awards Received by The Academic Staff 2004

Prof. Zainal Arifin Mohd Ishak	Georg Forster Research - Alexander von Humboldt foundation Germany
Prof. Hanafi Ismail	Saintis Cemerlang 2004 Kementerian Pengajian Tinggi Malaysia
Prof. Dr. Radzali Othman and his team members	IENA 2004 (Gold) Reformulated Calcium Phosphate for Human Tissue Transplantation (Synthetic Bone)
Assoc. Prof. Dr. Khairun Azizi Mohd Azizli and her team members	Malaysian Construction Industry Excellence Awards 2004 HIQSA: High Quality Shape Aggregates R & D Project of the Year Awards
Assoc. Prof. Dr. Luay Bakir Hussain and his team members	MOSTE 2004 (Bronze) Production of light and strong structures from recycled Materials
Prof. Dr. Hj. Zainal Arifin Ahmad Prof. Dr. Radzali Othman Assoc. Prof. Dr. Ahmad Fauzi Mohd Nor	Anugerah Khidmat Bakti EMSM 2004 Electron Microscopy Society Malaysia
Prof. Dr. Hj. Zainal Arifin Ahmad and his team members	MOSTE 2004 (Silver) FlexiTech Ceramic
Prof. Dr. Radzali Othman and his team members	MOSTE 2004 (Bronze) DURAGLASS (Durable Durian and Rambutan Glasses)

New Academic Staff 2004

Dr. Chow Wen Shyang

Dr. Ahmad Azmin Mohamad

Dr. Zainovia Lockman

Dr. Projjal Basu

Dr. Cheong Kuan Yew

New Administration Staff 2004

Salinatin Binti Mohamad Saleh

Senarai Geran Penyelidikan yang Diperolehi pada Tahun 2004

Penyelidik	Tajuk Geran	Jumlah (RM)
Cik Khatijah Aisha Yaacob Dr. Sabar Derita Hutagalung Dr. Sutapa Roy Ramanan Assoc. Prof. Dr. Rizal Astrawinata	The Development of Electron Transport Analysis Techniques in Quantum Dots/Wires **(TOP DOWN IRPA)**	1,945,240
Cik Khatijah Aisha Yaacob Dr. Sabar Derita Hutagalung	Study on the effect of Dopant Atom to CoSi2 Layer Subjected to temperature Increase **(SHORT TERM USM)**	9,453
En. Mohd Nazri Idris Prof. Dr. Radzali Othman	Penghasilan dan Kajian Sifat-sifat terhadap bahan kaca Seramik Berliang **(SHORT TERM USM)**	10,452
Prof. Madya Azizan Aziz	Synthesis of Nanostructured TiALB Mechanical Alloying for Aerospace Structure Application **(SHORT TERM USM)**	9,714
Dr. Azura Abdul Rashid Prof. Hanafi Ismail	An investigation of effect of ageing on mechanical properties of elastomer **(SHORT TERM USM)**	8,760

INTERNATIONAL GRANT

1. "Low CTE Substrate to improve solder joint reliability" (INTEL Grant). Dr. Mariatti Jaafar, Dr. Hazizan Md. Akil & Dr. Nasir (60,000)
2. "Nano Structural Electrode Tips for Spot Welding Application" (AUN-SeedNet Grant). Prof. Madya Dr. Luay Bakir Hussain & En. Ahmad Badri Ismail (6,779.20)
3. "Preparation and Properties of Polymer Clay Nano Composite" (AUN-SeedNet Grant). Prof. Dr. Hanafi Ismail (6,779.20)

CONSTRUCTION INDUSTRY DEVELOPMENT BOARD GRANT

1. "Ceramic Foam Core Sandwich Composite for Structural Development". Prof. Dr. Zainal Arifin Ahmad & Dr. Hazizan Md. Akil (452,000)

GERAN YAYASAN FELDA

1. "A study of adsorption of cuvetive materials in film of natural rubber latex". Assoc. Prof. Dr. Baharin Azahari (189,000)

Kemanakah Bangsaku?

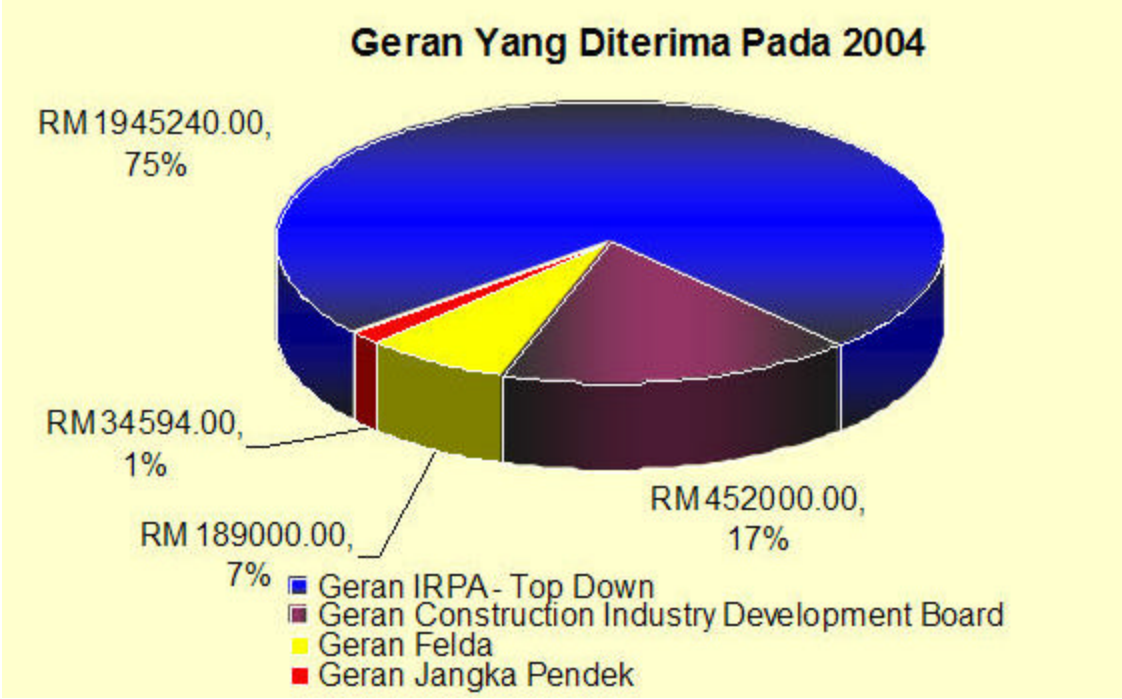
Kemanakah bangsaku?
Setelah 47 tahun merdeka
Mereka masih begini dan begitu

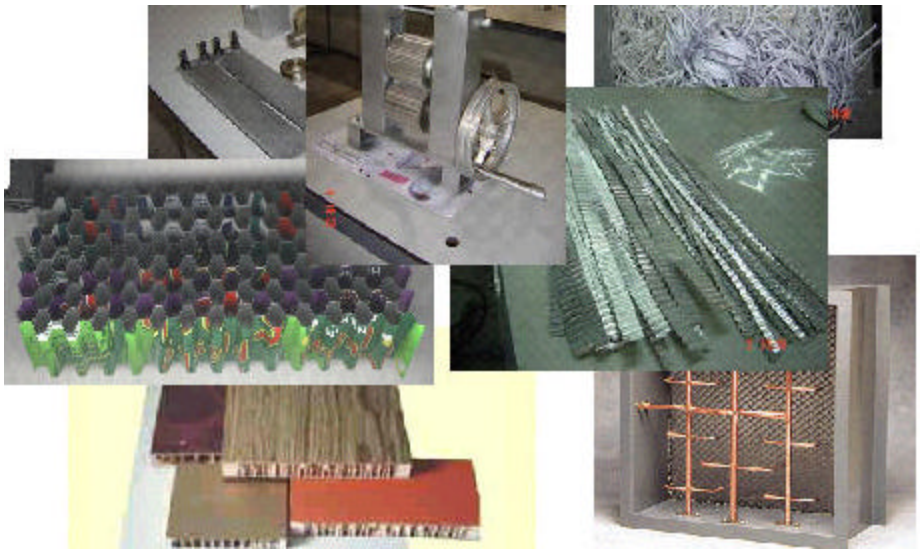
Kemanakah bangsaku?
Bukan tidak berubah tetapi
perubahannya
kecil untuk diperhitungkan dan
dibanggakan
Cuba lihat siapa empunya banglo besar,
kereta besar,
supermarket besar.....
Banggakah bangsaku dibumi
yang kaya ini?

Kemanakah bangsaku?
Benarlah kata Tun Dr. Mahathir,
bangsaku mudah lupa
Merdekakah mereka dibumi sendiri?

Kemanakah bangsaku?
Ingat puisi Pak Lah
Aku cari mana dia Al Ghazali
Aku cari mana dia Al Shafie
Kita bongkar rahsia kitab suci
Cari pedoman
Kita bongkar rahsia sunnah nabi
Cari panduan
Setelah TSUNAMI (**T**uhan **S**uruh **U**mat **Na**bi **M**uhammad **I**nsaf)
Kemanakah bangsaku?

PROF P





Production of light and strong structures from recycled Materials

Associate Prof. Dr Luay Bakir Hussain
Dr Hazizan Akil
Mr. Sharul Ami Zainal Abidin
Mr.Issa A. Ali. Hakim
Mr. Mohd Rafian

A new continuous production concept for low cost honeycomb core materials from a single corrugated recycled, wrought aluminum sheets and recycled papers has been developed. The low production costs will open new markets for honeycomb materials for many industrial applications starting from Rocket, Artificial Satellite, and other products in the aerospace field, Service Cart, Galley, and other airborne equipment, Flap Panel of aircraft wing, Infrared Stove and other electrical appliance, Shock-absorber for car crash test, structural Panels, Airflow Measuring Stations to Cockpit structure frame of solar car,...etc. Corrugate rolling die was design using AutoCAD software and fabricated in house to corrugate various width of wrought and directly recycled aluminum beverage cans. The adhesive is applied to the nodes of corrugated aluminum sheets and then the sheets are stacked and cured to produce the honeycomb core structure.

Recycled papers are shredded and then blended to fill the honeycomb cells for thermal insulation; sound damping and strength purposes are applied.

Face sheets made of thin aluminum; glass fiber epoxy and recycled papers epoxy are fixed onto top and bottom of honeycomb core.

The produced panels were tested and the results were excellent in the application of bending strength, compression strength, impact strength, thermal insulation and sound depending on frequency and amplitude of the sound manufactures who adopt this project do need to implement radical changes but however, can easily expand it for varieties of applications and obtain the obvious benefits.

1) Lower cost of operation
2) Greater throughput at little or no increased cost
3) Consistently good, creative products
4) Reduce pollution by using waste materials

Rubbery Water-based Thermoset Foam

Dr. Azhar Abu Bakar

Introduction

Improvement in foaming, production techniques and properties of thermosetting foams have contributed to their prominence as materials for wide range of applications. The matrix of this foam is based on cross-linked polymers so that, like the bulk plastics from which they are derived, they have generally good resistance to solvents and most chemical. Although some show limited plastic flow at elevated temperature, thermoset foams do not usually exhibit a melting range and can often be used at higher temperature than thermoplastic foams. In the production of thermoset foams, foaming takes place at the same time as the polymer is built up by the reaction of liquid starting materials.

Process

The rubbery water-based thermoset foam was produced from ordinary thermoset resin (epoxy), curing agent (polyamide) and stabilizer. However, some modifications were made to the system in term of processing and ingredients used. By changing the process and ingredients (rubbery and white in colour) without adding any rubber and it feel like rubber and not like ordinary thermoset foam, which is either very elastic or rigid and usually yellowish in colour. A series of rubbery foam with different properties can be produced by just changing the formulation accordingly (process control is very easy) for example by changing the ratio of epoxy and curing agent or by changing the water content. Using this method can also produce semi-rigid and rigid foam. So, each type of foam will have different properties and can be used for different application.

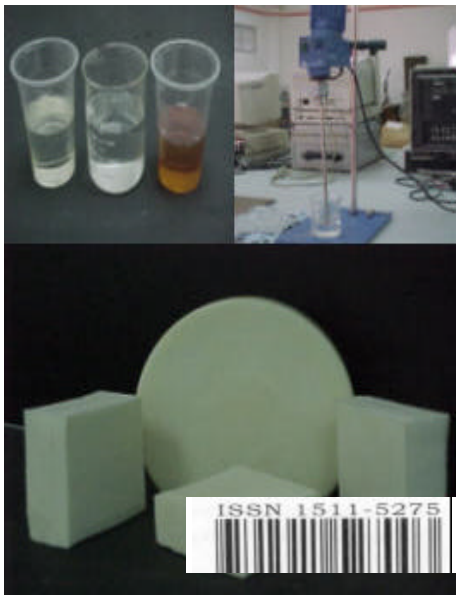
Advantages

The most important thing in this new system is the use of water as the medium in producing the foam. This can eliminate the use of corrosive and expensive solvent and hence, protect the environment (environmental friendly). Furthermore, only simple machines are used in producing this rubbery foam such as stirrer, homogenizer, oven and metal or plastic mould. Time to produce this type of foam also is very short.

By producing this rubbery water based thermoset foam, we can exploit the special properties of thermoset resin (in this case epoxy resin) such as thermal stability, chemical and flame resistant but still have the properties like rubber or thermoplastic foams.

Possible Application

This rubbery water based thermoset foam can be used in many applications such as for insulation in automotive industries or as core material in the production of composite sandwich panels for special applications. Since the properties of this rubbery foam can be controlled by just changing the formulation and processing, foams for different applications can easily be produced.



ISSN 1511-5275