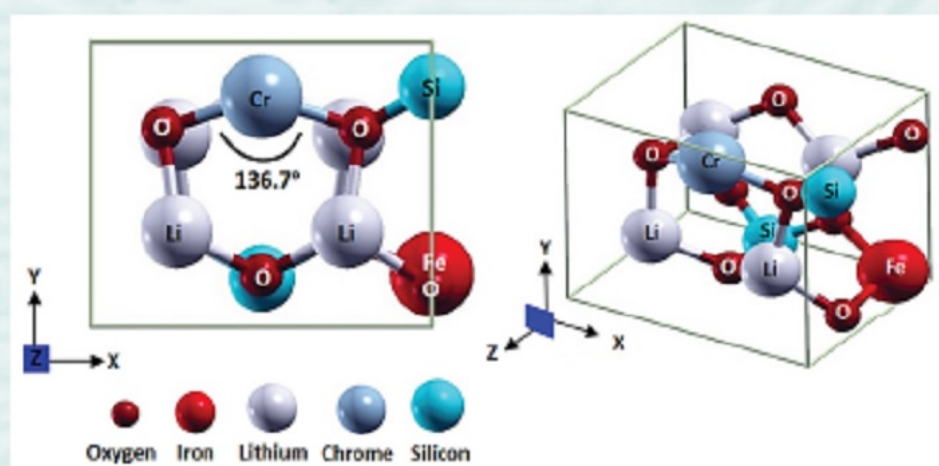


Advanced Materials Research and Production



Edited by
Ferry Iskandar, Satria Zulkarnaen Bisri,
Mikrajuddin Abdullah,
Khairurrijal and Kikuo Okuyama

Preface

It is a pleasure to conclude The 1st International Conference of The Materials Research Society of Indonesia (MRS-Id Meeting) 2014 with a great success. MRS-Id Meeting is a bi-annual society meeting of The Materials Research Society of Indonesia/Himpunan Riset Material Indonesia (MRS-Id/HRMI). The 1st MRS-Id meetings was successfully held in Denpasar, Bali, Indonesia on September 26th-28th, 2014. It was also co-organized by The Physics of Electronic Materials Research Division, Faculty of Mathematics and Natural Science of Institut Teknologi Bandung (ITB).

The MRS-Id meetings provides excellent opportunities for scientists, researchers and engineers to share their newest scientific works and discoveries in the field related to the broad scope of Material Science & Engineering. This event also become the melting pot where Indonesian and regional communities of materials scientists, physicists, chemists, engineers, as well as material-related business practitioners convene and exchange ideas. The aims of this event is to deliver the focus of MRS Indonesia which is to promote materials related science and technology in Indonesia, regional area (such as ASEAN and Asia) and global. We hope by this event, we can also issue a collection of scientific articles by researches in Material science fields.

In this 1st MRS-Id meetings, there were more than 250 participants not only from Indonesia, but also from Malaysia, Japan, The Netherlands, Australia, France, Germany, India, Singapore, and South Korea. There were more than 200 (oral and poster) presentations, including 6 plenary lectures, 23 invited talks, and 2 tutorial workshops. The meetings consisted of 9 independent parallel symposia that thoroughly discuss the wide spectrum of materials science and technology. Those symposia are: (a) Optics, Magnetic and Strongly Correlated Electron Materials; (b) Catalysts, Adsorbents and related materials: Fundamentals & Applications; (c) Photovoltaics and Batteries: Emerging Materials and Devices; (d) “Tear and Wear”: Materials for Industries and Strong Materials; (e) Biomaterials, Medicinal Materials and Drug Delivery; (f) Advanced Materials: Green Synthesis and Nanostructured Materials; (g) Organic and Hybrids: Materials, Devices and Physics; (h) Computational Methods and Advanced Characterizations of Materials; (i) Mining and Metallurgy: “Bringing up the added value”. This number of symposia reflects the emerging research field of material science and technology in Indonesia, and it is expected to be increased in the coming MRS-Id Meetings.

This special issue consists of full paper submitted from authors of the 1st MRS-Id Meetings. There were 130 full manuscripts submitted for this meetings. After scrutinized by thoroughly editorial and peer-review processes involving 74 experts worldwide, The experts were chosen not only because of their scientific expertise in the related field, but also due to their willingness to provide meticulous feedbacks that would improve both the scientific quality of the manuscript content and the writing process beyond the preparation of the manuscript. 124 papers were accepted for publications in this special issue.

For the success of the 1st MRS-Id meetings, The Materials Research Society of Indonesia would like to acknowledge all members of The Advisory Board, all members of The Organizing Committee, and The Faculty of Mathematics and Natural Sciences of Institut Teknologi Bandung, for the numerous supports. High gratitude is also conveyed to institutions and companies that support the funding of this meeting,

which are Institut Teknologi Bandung, PT. HORIBA Indonesia, Lab. Sistematika Indonesia.and Aston Hotel International Denpasar.

The next MRS-Id Meetings will be held in October 2016. **We are looking forward to welcoming you in the 2nd MRS-Id Meetings!**

Prof. Mikrajuddin Abdullah
Chairman of MRS-Id Meeting 2014 / current President of MRS-Id

Ferry Iskandar
Co-Chairman of MRS-Id Meeting 2014

Ferry Iskandar, Satria Zulkarnaen Bisri, Prof. Mikrajuddin Abdullah, Prof. Khairurrijal and Prof. Kikuo Okuyama
Editorial Board

Table of Contents

Preface

Chapter 1: Optics, Magnetic and Strongly Correlated Electron Materials

Optical Band Transitions and Excitonic States in ZnO:Cu Films Y. Darma and A. Rusydi	3
Optical Properties of Erbium Doped Borotellurite Glass System M.K. Halimah, M.N. Azlan and S.Z. Shafinas	7
Characterization of Mg_{0.8}Zn_{0.2}TiO₃ Prepared via Liquid Phase Sintering M. Saukani and S. Suasmoro	11
Synthesis and Electrical Characterization of 0.8(K,Na)NbO₃-0.2(Ba,Ca)(Zr,Ti)O₃ Lead-Free Ceramics N.A. Rohmah, N. Hikmah and S. Suasmoro	15
Crystal Structure and Magnetic Properties of Zn Doped Barium M-Hexaferrite U. Nuraini, L. Amalia, K.C. Rosyidah and M. Zainuri	19
Raman Spectra of Multiferroics TbMnO₃ I.P. Handayani, N. Mufti, A.A. Nugroho, T.T.M. Palstra and P.H.M. van Loosdrecht	23
Structure and Magnetic Properties of Spark Plasma Sintered NdFeB T. Sudiro, D. Aryanto, N.R. Djauhari, C.W.B. Sinuraya, S. Humaidi and N. Sudrajat	27
The Influence of Glucose Concentration to Resonant Wavelength Shift of Polymer-Based Microring Resonators B. Mulyanti, L. Hasanah, T. Hariyadi, R. Novitasari, A.B. Pantjawati, H. Yuwono and K. Khairurrijal	32
Verification of Theoretical Model for Tunneling Currents in Al/SiO₂/p-Si MOS Capacitors with Nanometer-Thick Oxides B. Mulyanti, L. Hasanah, A.B. Pantjawati, H. Murakami and K. Khairurrijal	37
Theoretical Investigation on Electronic Properties of ZnO Crystals Using DFT-Based Calculation Method Y. Darma, F.G. Setiawan, M.A. Majidi and A. Rusydi	41

Chapter 2: Nanostructured Materials and Nanotechnologies

A Simple Dissolved Metals Mixing Route to Prepare Nanostructured Mg_{0.8}Zn_{0.2}TiO₃ Solid Solution F.U. Ermawati, S. Suasmoro and P. Suminar	47
Characterizations of Carbon Nanospheres Synthesized Using Activated Carbons and Palm Oil A. Andreas Arie, H. Kristianto, R.F. Susanti, H. Devianto, M. Halim and J.K. Lee	53
Stress – Strain Analysis on ZnO Nanostructures Synthesized via Wet Chemistry Method A. Sholehah and A.H. Yuwono	57
Synthesis and Characterization of Zero-Valent Iron Nanoparticles E.S. Yusmartini, D. Setiabudidaya, Ridwan, Marsi and Faizal	62
Synthesis of Various ZnO Nanotree Morphologies through PEG-Assisted Co-Precipitation Method R. Mahendra, M. Arianti, D. Sawitri and D.D. Risanti	66
<i>Thevetia peruviana</i>: A Wild Natural Resource for the Green Synthesis of Gold Nanoparticles N.N. Rupiasih, A. Aher, S. Gosavi and P.B. Vidyasagar	71
Synthesis of Antibacterial Nanofibrous Membrane Based on Polyacrylonitrile (PAN)/Chitosan by Electrospinning Technique for Water Purification Application M. Prama Ekaputra, M.M. Munir, A. Rajak, A. Rahma, A.Y. Nuryantini and Khairurrijal	76

Electron Tunneling Current in an n-p-n Bipolar Transistor Based on Armchair Graphene Nanoribbon by Using Airy-Wavefunction Approach F.A. Noor, R. Syariati, E. Suhendi, M. Abdullah and Khairurrijal	80
Electrical Properties of Carbon-Based Thin Film on Al₂O₃/Si H. Alfiadi, A. Virdian and Y. Darma	85
Formation of Porous Anodic Alumina from Impure Aluminum Foil in Inorganic Acids A. Nurrudin, B. Yulianto, Suyatman and A. Sriwongo	89
Covalent Functionalization of Graphene Flakes with Well-Defined Azido-Terminated Poly(-caprolactone) and Poly(2-oxazoline) N. Abdullah, K. Hatano, D. Ando, K. Hirata, M. Kubo, A. Koshio and F. Kokai	94
Graphene-Based Flexible Circuit on Cotton Fabric Using Wax Patterning Method C.L. Lam, M.F. Mohd Rafi, M.F.H. Mohd Fishol, M.B. Mohd Yudin, A. Michi, C. Sriprachubwong, A. Tuantranont and D.H.B. Wicaksono	98
Modeling of Electron Tunneling Current in a p-n Junction Based on Strained Armchair Graphene Nanoribbons with Extended Tight Binding and Transfer Matrix Method R. Syariati, E. Suhendi, F.A. Noor and K. Khairurrijal	102
Study of Carbon Thin Film Deposition on Various Buffer Layer as Characterized by X-Ray Diffraction and Raman Spectroscopy A. Virdian, H. Alfiadi and Y. Darma	106
Topographic and Electronic Properties of 3,4,9,10-Perylene Tetra Carboxylic Dianhydride (PTCDA) on Indium Tin Oxide (ITO) Surface Arramel, T. Hasegawa, T. Tsuruoka and M. Aono	110
The Methanol Response Sensing Properties Using MWCNT-ZnO Composite N.L.W. Septiani, B. Yulianto, M. Iqbal, Suyatman, A. Nuruddin and Nugraha	116
Laser Ablation of Nanoparticles: A Molecular Dynamics Study R. Fahdiran and H.M. Urbassek	120
Optical Properties and Interband Transitions of ZnO and Cu-Doped ZnO Films Revealed by Spectroscopic Ellipsometry Measurement R. Marlina, A. Rusydi and Y. Darma	124
Simulation of Dirac Electron Tunneling Current in Armchair Graphene Nanoribbon Tunnel Field-Effect Transistors Using a Transfer Matrix Method E. Suhendi, R. Syariati, F.A. Noor, N. Kurniasih and Khairurrijal	128
External and Internal Influences in Silicene Monolayer M. Syaputra, S. Arman Wella, A. Purqon and Suprijadi	133

Chapter 3: Catalysts, Adsorbents and Related Materials: Fundamentals and Applications

Development of Emulsion Gels and Macroporous Hydrogels and their Applications to Metal Adsorption and Enzyme Reaction H. Tokuyama	141
Gas Permeation Study of Carbon Tubular Membrane by Manipulating Carbonization Temperature Profile W.N.W. Salleh, N. Sazali, H. Hasbullah, N. Yusof, J. Jaafar and A.F. Ismail	145
Application of Immobilized Titanium Dioxide as Reusable Photocatalyst on Photocatalytic Degradation of Methylene Blue Sutisna, M. Rokhmat, E. Wibowo, R. Murniati, Khairurrijal and M. Abdullah	149
Thermally Activated Clay to Compete Zeolite for Seawater Desalination E. Wibowo, M. Rokhmat, Sutisna, R. Murniati, Khairurrijal and M. Abdullah	154
The Role of Fe²⁺ Ions on the Photocatalytic Reaction of Ag₃PO₄ for Rhodamine B Degradation A. Riapanitra, I. Futihah, U. Sulaeman, S. Yin and T. Sato	158
Synthesis of Bi₂O₃/Ag₃PO₄ Composites and their Photocatalytic Activities under Visible Light Irradiation U. Sulaeman, E. Yunari, P. Iswanto, S. Yin and T. Sato	163
Photocatalytic Removal of 2,4-D Herbicide on Lanthanum Oxide-Modified Titanium Dioxide W.R. Siah, N.A. Roslan, H.O. Lintang, M. Shamsuddin and L. Yuliaty	168

Synthesis of Mesoporous Silica Particles with Fibrous Morphology via Self-Assembly Process in Microemulsion System E. Febriyanti, R.R. Mukti, V. Suendo, I.N. Marsih, S. Triwahyono, S. Ismadji and Ismunandar	172
Photocatalytic Oxidation of Hexanol over Titanium Dioxide Supported on Mesoporous Silica N.U. Mohd Nor, H.O. Lintang, S. Endud and L. Yuliati	176
Enhanced Photocatalytic Performance of Copper-Modified Titanium Dioxide Prepared by UV Reduction Method N.A. Roslan, H.O. Lintang and L. Yuliati	180
Reduced Graphene Oxide-Mesoporous Carbon Nitride as Photocatalyst for Removal of N-Nitrosopyrrolidine P. Tiong, H.O. Lintang, S. Endud and L. Yuliati	184
The Immobilization of Pt/WO₃ on the Glass Substrate for Methylene Blue Degradation I. Firdaus, A. Purwanto and H. Widiyandari	188
The Influence of Montmorillonite Incorporation in Mn-Doped ZnO Nanoparticles for Photocatalytic Degradation of Organic Dyes N.F. Djaja and R. Saleh	194
A Comparative Study of the Synthesis of MFI Zeolite by Using High- and Low-Temperature Heating G.T.M. Kadja, R.R. Mukti, I. Nyoman Marsih and Ismunandar	201
Synthesis of Fe₃O₄ Nanoparticles Using the Co-Precipitation Method and its Development into Nanofluids as a Catalyst in Aquathermolysis Reactions F. Iskandar, A. Asbahri, E. Dwinanto, M. Abdullah and Khairurrijal	205
Photocatalytic Activity Inhibition by ZnO-SiO₂ Nanocomposites Synthesized by Sonochemical Method Widiyastuti, I. Maula, S. Machmudah, T. Nurtono, S. Winardi and K. Okuyama	209
Synthesis of CuFe₂O₄-Bentonite Composite for Adsorption of Ni(II) from Electroplating Wastewater P.L. Hariani, F. Riyanti, Fatma and S. Sutriani	213
Computational Density Functional Theory Study of Hydrazine Adsorption on Ni(110) Surface K.T. Aji, P.H. Purwoko, A.D. Refino, M.K. Agusta and H.K. Dipojono	217
Preparation of Fe₃O₄/TiO₂ and Fe₃O₄/TiO₂/CuO Nanohybrids for Photoreduction of Cr(VI) S.A. Arifin, S. Jalaludin, N.F. Djaja and R. Saleh	221

Chapter 4: Photovoltaics, Batteries and Fuel Cells: Emerging Materials and Devices

Graphene and Activated Carbon Based Supercapacitor Electrodes M. Deraman, N.S.M. Nor, N.H. Basri, B.N.M. Dollah, S. Soltaninejad, R. Daik, R. Omar, M.A. Hashim@Ismail and M.A.R. Othman	231
Electrochemical Impedance Spectroscopy Study of Supercapacitors Using Deposited Nickel Oxide Nanoparticles Carbon Monolith Electrodes N.H. Basri, M. Deraman, R. Daik, M.T.M. Ayob, M.I. Sahri, N.S.M. Nor, B.N.M. Dolah and S. Soltaninejad	236
Synthesis and Characterization of Li₄Ti₅O₁₂ Doped by Na and Al as Anodes Material for Li-Ion Batteries S. Priyono, B. Prihandoko and A. Zulfia	241
Enhancement of TiO₂ Particles Based-Solar Cells Efficiency by Addition of Copper(II) Nitrate and Post-Treatment with Sodium Hydroxyde M. Rokhmat, E. Wibowo, Sutisna, E. Yuliza, Khairurrijal and M. Abdullah	245
Photovoltaic Characteristics of Inverted Bulk-Heterojunction Organic Solar Cells with Titanium Doped ZnO as their Electron Transport Layer Y.S. Handayani, P. Wulandari and R. Hidayat	251
Photovoltaic and Impedance Characteristics of Quasi Solid-State Dye-Sensitized Solar Cell Using Polymer Gel Electrolytes W.S. Arsyad, Herman, Fitrilawati and R. Hidayat	256
Enhancing the Value of Local Silica Sand from Bancar as a Fuel-Cell Sealing Material E. Dewa, Musyarofah, U. Nurbaiti, Triwikantoro, S. Firdaus and P. Suminar	262

Composite Electrolyte of SOFC Based on Stabilized Zirconia 1Yb10ScSZ Nanopowder J. Raharjo, O. Arjasa, Agustanhakri and Damisih	266
Evaluating Capacitive Deionization for Measurements of the Salt-Removal of NaCl, KCl and MgCl at Various Cell Voltages D. Anggoro and Endarko	271
Proton Conducting Biopolymer Electrolytes Based on Starch Incorporated with Ammonium Thiocyanate F.N. Zulkefli, S. Navaratnam and A.H. Ahmad	275
Effect of Al₂O₃ on the Electrical Conductivity of MgI₂-Mg₃(PO₄)₂ Solid Electrolyte A.H. Ahmad and A. Aziz	279
Absorbance Studies of Perovskite CH₃NH₃PbI_(3-x)Cl_x as Light Harvester in Solar Cell P. Noorlaily, M. Ulfa, S.Z. Bisri and F. Iskandar	282
First Principle Calculation of Li₂Fe_{0.5}Cr_{0.5}SiO₄ for Li-Ion Battery Cathode G. Kurniawan Sukandi, T.D. Kencana Wungu and F. Iskandar	286
Synthesis of Reduced Graphene Oxide (rGO)/Ni Composite by a Combination of Marcano's and Microwave Assisted Reduction Methods F. Iskandar and Y. bin Rus	290
Phase Analysis of Natural Silica-Sand-Based Composites as Potential Fuel-Cell Seal Material G.A. Gita Aristia, Istiqomah, N. Hidayat, Triwikantoro, M.A. Baqiya and S. Pratapa	294
Supercapacitor Carbon Monoliths Electrodes from Activation of Precarbonized Biomass Fibers Added with Cellulose Powder S. Soltaninejad, M. Deraman, R. Daik, N.S.M. Nor, B.N.M. Dolah, N.H. Basri, N.E.S. Sazali, E. Hamdan and M.R.M. Jasni	299
Supercapacitor Activated Carbon Electrode from Composite of Green Monoliths of KOH-Treated Pre-Carbonized Oil Palm Empty Fruit Bunches and HNO₃-Treated Graphite N.S.M. Nor, M. Deraman, N.H. Basri, B.N.M. Dollah, R. Omar, S. Soltaninejad, R. Daik and M.D. Norizam	303
Effects of Activation Time on the Performance of Supercapacitor Binderless Activated Carbon Electrodes Derived from Fibers of Oil Palm Empty Fruit Bunches M.M. Ishak, M. Deraman, B.N.M. Dolah, M.A.R. Othman, R. Omar, N.H. Basri, N.S.M. Nor, E. Taer, Awitdrus, R. Farma and A.A. Aziz	308
On the Role of NaCl Addition to Phase Transformation of TiO₂ from TiCl₃ I.E. Putri, H. Ariesta Budiarti, D. Sawitri and D.D. Risanti	313
Theoretical Investigation of Anthocyanidin Aglycones as Photosensitizers for Dye-Sensitized TiO₂ Solar Cells E. Cahya Prima, B. Yulianto, Suyatman and H.K. Dipojono	317

Chapter 5: Surfaces, Coatings and Hardening of Materials for Industrial Application

The Improvement of Product Quality and Production Capacity of Metal Coin Dies by Tempering Treatment and PVD TiN Coating in Isodur™ Steel M. Fitrullah, M. Hendra, A.A. Alhamidi, A. Herliawan, A. Aziz, D. Yanyan, T. Adhitya, P. Tri and J. Andinnie	323
Correlation between Frequency and Sound Absorption Coefficient of Polymer Reinforced Natural Fibre M. Farid, H. Ardhyanta, V.M. Pratiwi and S.P. Wulandari	329
The Synthesis of Ethyl-1-Benzyl-5-Methyl-1H-1,2,3-Triazoles-4-Carboxylate Using Microwave Assisted Organic Synthesis Method and Determination of its Corrosion Inhibition Activity on Carbon Steel R.M. Syifa Insani, D. Wahyuningrum and B. Bundjali	333
Analysis of YSZ-Al₂O₃/YSZ Flame Sprayed Thermal Barrier Coating to Thermal Resistance Widyastuti, K. Parindra, L. Mariani, H. Ardhyanta and Sulistijono	338
Objective and Combinational Analysis of Multiple Kinds of Data Obtained from Severe-Mild Wear Transition K. Fukuda and T. Morita	345

Comparative Studies on Thermal Barrier between Modified Polyurethane Using Titanium Dioxide to Montmorillonite Nanoclay R. Zakaria and A.H. Ahmad	349
Effect of Pack Cementation Temperature on Oxidation Behavior of NiCoCrAl Coated Layer E. Sugiarti, K.A. Zaini, Y.M. Wang, N. Hashimoto, S. Ohnuki and S. Hayashi	353
Curing Time and Water Repellent Properties of Dammar-Titanium Dioxide Thin Film A.N. Hasnan and A.H. Ahmad	359
Hot Corrosion of Aluminide Coated Ti-Al-Cr-Nb-Zr-Y Intermetallic Alloys E. Basuki, F. Mohammad, A. Fauzi and D. Prajitno	363
Development of Sound Absorbent Material Based on Waste and Bamboo Fiber A.B. Pantjawati, E.A. Juanda, B. Mulyanti, A. Mujtahid and A. Wiryadi	367

Chapter 6: Polymers and Composites: Synthesis and Properties

Tensile and Flexural Properties of Montmorillonite Nanoclay Reinforced Epoxy Resin Composites Z.S. Alsagayar, A.R. Rahmat, A. Arsad and S.N.H. binti Mustaph	373
Flexural Properties of MMT Reinforced Unsaturated Polyester/Epoxidized Palm Oil Biobased Resin S.N.H. binti Mustaph, A.R. Rahmat, A. Arsad, Z.S. Alsagayar and Y. Shoot Kian	377
Effect of Magnesium on Hardness and Microstructure of Metal Matrix Composite Al₆₀₆₁/(Al₂O₃)_p Produced by Stir Casting Route S. Junus, A. Zulfia and L. Mariani	381
Dynamic Mechanical Properties of PEG 4000 + Quartz Composites F. Nur Aini, Musyarofah, Triwikantoro, Mashuri, S. Firdaus and P. Suminar	385
Effect of Composition Variation on the Mechanical Strength of Domestic Waste-Based Composites N. Surtiyeni, E. Yuliza, N. Kurniasih, K. Khairurrijal and M. Abdullah	389
Effect of Mica Content on Mechanical Properties of Regenerated Cellulose Nanocomposites via Ionic Liquids N. Abdul Hanid, M.U. Wahit and Q.P. Guo	393
The Effect of Silica Nanoparticle Filler and Mg(OH)₂ Particle Addition on the Compressive Strength of Rice Husk Composite I. Sriyanti, L. Marlina, D. Edikresnha, Khairurrijal and M. Abdullah	397
Effects of Stabilization Temperature on the Chemical and the Physical Properties of Polyacrylonitrile Stabilized Fibers N. Yusof, A.F. Ismail, J. Jaafar, W.N.W. Salleh and H. Hasbullah	402
Development of Statues from Domestic Waste Composites Coated with Carboneus Phosphor Materials M. Nurhanisa and M. Abdullah	406
Effect of Curing Temperature and Cross-Linker to Pre-Polymer Ratio on the Viscoelastic Properties of a PDMS Elastomer F. Prabowo, A.L. Wing-Keung and H.H. Shen	410
Characterization of Chitosan-Acrylamide Hydrogels as Soil Conditioner K.T. Basuki, D. Swantomo, Sigit and N.T. Sanyoto	414

Chapter 7: Biomaterials and Biomedical Engineering

Effect of Alloying Elements on Microstructure of Biomedical Co-Cr-Mo F75 Alloy Alfirano	421
Reduction of Harmful Substances in Cigarette Smoke Using TiO₂ Nanoparticles R. Murniati, Sutisna, E. Wibowo, M. Rokhmat, N. Surtiyeni, E. Yuliza, Khairurrijal and M. Abdullah	425
The Influence of Non-Ionic Surfactant on the Physical Characteristics of Curcumin-Loaded Nanofiber Manufactured by Electrospinning Method A. Rahma, M.M. Munir, Khairurrijal and H. Rachmawati	429

Cytotoxicity Test of Brown Silk from <i>Attacus atlas</i> L. on Rat Smooth Muscle Cells M.F. Ulum and D. Noviana	433
Cotton Thread for Size-Based Blood Cells Sorting F. Yazdani, S. Sadir, F.Z. Huyop and D.H.B. Wicaksono	437
Wax-Impregnated Cotton Fabrics as Cell Culture Platform N.M. Wahab, S. Abdul Jamil, D.G. Riban, F.A. Abdul Majid, M.R. Abdul Kadir and D.H.B. Wicaksono	441
Effect of Propofol and Isoflurane Long-Term Anesthesia on Rabbit's Heart Size as Consideration for Biomaterial Implant Placement S.F. Siallagan, K.T. Tan, M. Fakhrol Ulum, Gunanti and D. Noviana	445
<i>In Vitro</i> Cytotoxicity and <i>In Vivo</i> Tissue Response Study of Foreign Bodies Iron Based Materials D. Noviana, S. Estuningsih, D. Paramitha, M. Fakhrol Ulum and H. Hermawan	449
Poly(Vinyl Alcohol)/Chitosan Nanofibrous Membrane Containing <i>Anredera cordifolia</i> (Ten.) Steenis A.Y. Nuryantini, M.M. Munir, A. Rahma, T. Suciati and Khairurrijal	453
Synthesis of Chicken's Eggshells-Based β-Tricalcium Phosphate Bioceramics K. Dahlan and N.A. Nuzulia	458
Microstructure and Mechanical Properties of Extruded Mg-1.6Gd as Prospective Degradable Implant Materials O. Susanti, S. Harjanto and M.A. Mochtar	462
Radiography Study of Iron-Based Foreign Body Material Degradation at Different Implantation Site in Mice D. Paramitha, D. Noviana, S. Estuningsih, M. Fakhrol Ulum and H. Hermawan	466
Radiodensity Study of Hydroxyapatite Coated Porous Tantalum Implant Material of Rat Animal Model B. Panjaitan, D. Noviana, Gunanti, I. Sukmana and M. Fakhrol Ulum	470
Sintering of Mg-Ca-Zn Alloy Metallic Foam Based on Mg-Zn-CaH₂ System D. Annur, M.I. Amal, C. Sutowo, S.G. Sukaryo and I. Kartika	474

Chapter 8: Mining, Metallurgy and Chemical Engineering

More from Less, Generating Wealth from Lower Grade and Urban Metal/Ore Sources M.A. Rhamdhani, A. Khaliq, G.A. Brooks, S. Masood, S. Ahmad and M.S. Islam	481
Friction Spot Welding of Similar AA5754 to AA5754 Aluminum Alloys and Dissimilar AA5754 Aluminum to AZ31 Magnesium Alloys U.F.H. Suhuddin, D. Piccolo, V. Fischer and J.F. dos Santos	485
The Influence of Calcination Temperature on Quantitative Phase of Hematite from Iron Stone Tanah Laut A. Mufid and M. Zainuri	489
The Processing of Low Grade Nickel Ore from South East Sulawesi Solihin, M. Zaki Mubarak, A. Hapid and F. Firdiyono	493
Study of Frangible Cu-Sn Composite by Powder Metallurgy Method Widyastuti, G.A. Vicko, H. Ardhyanta and R. Rochman	497
The Influence of Cooling Rate on Macroseggregation in Bi-Sn Alloy Y.M. Zulaida	502
Characterization of Various Types Coal Using Capacitance Measurement Technique D. Haryono, Desiani, M. Al Huda, W.P. Taruno, M.R. Baidillah and I. Maulana	506
Modification of Ceramic Mold for Investment Casting with Silica Sand as Stucco and Nylon Addition B.T. Sofyan, M. Syahid, H.A. Khairuddin and R. Nurdin	510
Reduction of Low Grade Iron Ore Using a Mixture of Polyethylene (HDPE/LLDPE) and Coal as an Alternate Reductant A. Milandia and S. Oediyani	515
Effect of TiO₂ and MgO on Microstructure of α-Alumina Ceramics and its Sintering Behavior J. Raharjo, S. Rahayu, T. Mustika, Masmui and D. Budiyo	519

Utilization of the Ibai River Sediment as a Raw Material for Producing Ceramic Glazes N. Siau Wei and M.A.A. Muhamad Nor	524
Study on the Geopolymerization of Geothermal Silica and Kaolinite M. Olvianas, M. Najmina, B.S.L. Prihardana, F.A.K.G.P. Sutapa, A. Nurhayati and H.T.B.M. Petrus	528
Effect of Fabrication Method by Powder Metallurgy on Frangibility Green Bullet Cu-10%Sn as Eco-Friendly Bullet K. Metrima Firmansyah, A. Septyantoko, M. Ghulam Isaq Khan, P. Jhony, R. Mardliah and Widyastuti	533
Mechanism of Macroporous Zirconia Particles Formation Prepared by Hydrothermal Synthesis S. Machmudah, O.P. Prastuti, Widiyastuti, S. Winardi, Wahyudiono, H. Kanda and M. Goto	538
SiO₂/MgO Ratio Effect on Carbothermic Reaction of Synthetic Nickelliferrous Mixtures S. Harjanto and R.M. Ulum	542
Synthesis of Magnesium Carbonate Using Indonesian Dolomite Solihin and E. Sulistiyono	546
Synthesis of Magnesia Powder from East Java Dolomite through Leaching, Precipitation and Calcination M.Z. Mubarok and C. Adi Kurniawan	550
Physical and Chemical Characteristics of Corals from Bidong Island, Terengganu, Malaysia A.A. Ahmad Zubir, Y. Yusof and M.A.A. Muhamad Nor	555
Sonocrystallization Technique to Optimizing the Crystallization Process of PCM CaCl₂.6H₂O I.D. Palittin, N. Kurniati, I.M. Sutjahja and D. Kurnia	559
The Effect of Additives on the Crystallization PCM CaCl₂.6H₂O for Stabilizing the Air Temperature for Energy Conservation N. Kurniati, I.D. Palittin, I.M. Sutjahja and D. Kurnia	563

Synthesis of CuFe_2O_4 -Bentonite Composite for Adsorption of Ni(II) from Electroplating Wastewater

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Abstract. CuFe_2O_4 -bentonite composite successfully synthesized using chemical co-precipitation method and using to adsorb Ni(II) from electroplating wastewater. The composite was characterized by Fourier Transform Infra Red and Scanning Electron Microscope-Energy Dispersive X Ray Spectroscopy. The FTIR spectra of CuFe_2O_4 -bentonite composite presented the characteristic of CuFe_2O_4 and bentonite. Typical of bentonite obtained by the bands at 1033.8 cm^{-1} correspondent to the intensity of Si-O. The observed two peaks at 432.0 cm^{-1} and 536.2 cm^{-1} attributed to the tetrahedral and octahedral of CuFe_2O_4 . The result indicated that CuFe_2O_4 particles deposited on the surface of bentonite. The main component of CuFe_2O_4 -bentonite composite contained of CuFe_2O_4 and bentonite from EDX spectra. Batch experiments were carried out to investigate optimum condition of adsorption Ni(II) onto CuFe_2O_4 -bentonite composite. The optimum condition for initial concentration of Ni(II) 50 mg L^{-1} and volume 50 mL obtained at weight of CuFe_2O_4 -bentonite composite of 100 mg , contact times at 60 minutes and pH of the solution 5 . The adsorption efficiency of Ni(II) from electroplating wastewater using CuFe_2O_4 -bentonite composite at optimum condition was 99.136% , respectively.

Introduction

The plating process in electroplating industry used about 30-40 % heavy metals [1]. Effluent of electroplating has low pH, high total solids, chlorides, sulphates and heavy metals such as Cr, Cu, Zn and Ni [2]. The presence of heavy metals in the environment is a serious problem because highly toxic, non-biodegradable, carcinogenic and bioaccumulation in organism [1]. For example, Ni(II) causes adverse health cancer, skin allergy, lung fibrosis, kidneys, gastrointestinal distress [2]. Concentration Ni(II) in the wastewater electroplating in the range $2\text{-}900\text{ mg L}^{-1}$ [3]. According to EPA standards the maximum Ni(II) content in drinking water is $20\text{ }\mu\text{g L}^{-1}$ [4]. Therefore, the treatment of electroplating wastewater is very essential.

The methods to treatment wastewater expected effective, simple and low cost. Adsorption method is one the most to treatment heavy metals from wastewater. It has been reported the method inexpensive and widely applicable [5]. Various adsorbents can be used to remove heavy metals such as activated carbon [1], chitin and chitosan [6]. Bentonite is one of the adsorbents can be used to absorb heavy metals because has ability to exchange ion at typical layered silicates structure [7]. Bentonite reserves in Indonesia is estimated to reach 380 tons [8]. Potential bentonite has not managed optimally. The effectiveness of adsorption increases if the modification of the adsorbent. Magnetic adsorbent has been widely used in wastewater treatment. Advantages of magnetic adsorbent can be used to adsorb organic and inorganic substances, separation process is simple and fast using permanent magnet. In the research, bentonite- CuFe_2O_4 composite adsorbent was employed to developed a new kind of magnetic adsorbent to adsorb Ni(II) from electroplating wastewater. CuFe_2O_4 has properties such as magnetic and catalytic [9,10]. In the experiments, batch adsorption are carried out at the temperature 25°C and effect of some parameters research include weight of composites, contact time and pH solution has been investigated.

Experimental

Bentonite from the South Sumatera, Indonesia. Bentonite dried in the oven at 110°C for 5 hours. Bentonite is crushed to powder and up to size 200 mesh. All the reagents were of analytical grade and used as received further purification. CuCl₂, FeCl₂, NaOH and NiCl₂ were purchased from Merck. Composite bentonite-CuFe₂O₄ synthesized from 2.69 g CuCl₂, 5.08 g FeCl₂ and 4.79 g bentonite was dissolved in 400 mL double distilled water (Mass ratio of bentonite:CuFe₂O₄ = 1:2). NaOH solution 5 M was added slowly to the solution until pH to around 10 under vigorous magnetic stirring at room temperature. The suspension was heated to 95-100°C for 2 hours [10,11]. After cooling, composite washed with distilled water until neutral pH. Composite separated from water by simple magnetic and dried in oven at 105°C for 3 hours. The characterization and morphology of the composites are identified using FTIR Shimadzu 5400 and SEM-EDX JEOL-JSM 1400.

In the adsorption experiment, the flask containing 50 mL of Ni(II) prepared from NiCl₂ with concentration 50 mg L⁻¹ added composite of onto 100-500 mg with shaking at 25°C for 15 minutes. After that, the composite were separated from the solution by simple magnet. The effect of contact time at various 15-75 minutes and pH at different pH value 3-9. The pH of the solution was adjusted with NaOH or HCl solutions. Concentration of Ni(II) were determined by Atomic Absorption Spectroscopy Shimadzu AA-6300. The optimum conditions obtained by adsorption capacity (q_t).

$$q_t = (C_0 - C_t) V / 1000 . m \quad (1)$$

Where q_t is the adsorption capacity (mg/g) at time t, C_0 and C_t are initial and equilibrium concentration (mg L⁻¹), m is the adsorbent dosage (mg), and V is the volume of the solution (mL). The optimum condition obtained was applied to adsorb Ni(II) from electroplating wastewater.

Results and Discussion

Characterization of Bentonite-CuFe₂O₄ Composite. FTIR spectra showed the functional group in the sample. There were recorded in the range 400-4000 cm⁻¹. Fig.1 showed FTIR spectra of CuFe₂O₄ and bentonite-CuFe₂O₄ composite.

Two absorption bands at 400-600 cm⁻¹ correspondent to the octahedral and tetrahedral sites positive ions of CuFe₂O₄ [11]. In this research, the higher absorption band at 594.0 cm⁻¹ correspondent tetrahedral form and the lower absorption bands at 443.6 cm⁻¹ to the vibrations of octahedral form. Wavenumber on bentonite-CuFe₂O₄ composite is a combination of wave numbers CuFe₂O₄ and bentonite. This proves the occurrence that CuFe₂O₄ has entered into intra layer bentonite. The main component of bentonite is montmorillonite. Montmorillonite has a specific absorption at wave number 3100-3700 cm⁻¹ which is the O-H stretching vibration and 1600-1700 cm⁻¹ which is the H-O-H bending vibrations of H₂O with hydrogen bonding onto montmorillonite. The peaks at 1033.0 cm⁻¹ with high intensity were associated with the Si-O stretching vibration, while supported the peaks at 470.0 and 536.2 cm⁻¹ were assigned to the Si-O bending vibration. Wavenumber shift indicates a change in energy levels, increased energy may occur because the bond CuFe₂O₄ with bentonite.

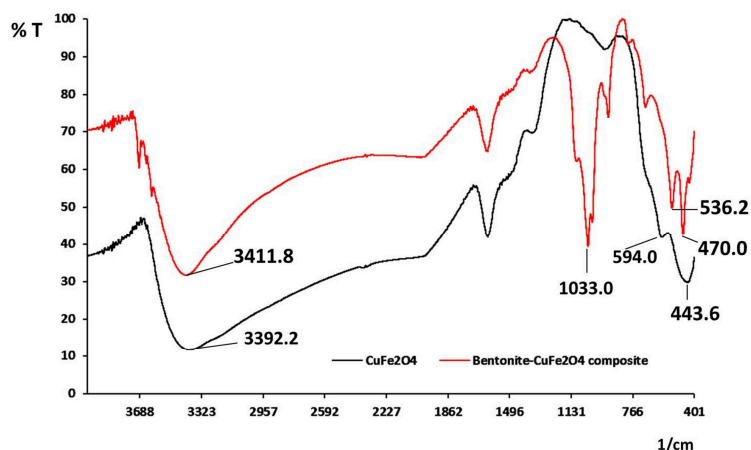


Fig. 1 FTIR spectra of CuFe₂O₄ and bentonite-CuFe₂O₄.

The morphology of the CuFe_2O_4 and bentonite- CuFe_2O_4 composite were investigated by SEM observations at Fig.2. The SEM images of CuFe_2O_4 was small in size and quite agglomerated while composite was large in size. The main component of CuFe_2O_4 from EDX spectra were O(26.7%), Fe(47.64%) and Cu(25.64%) while bentonite- CuFe_2O_4 composite contained of CuFe_2O_4 and bentonite such as O(30.37%), Na(1.04%), Mg(0.12%), Al(5.73%), Si(8.71%), Ca(0.41%), Fe(35.74%) and Cu(17.88%). It showed synthesise of composite has been successfully.

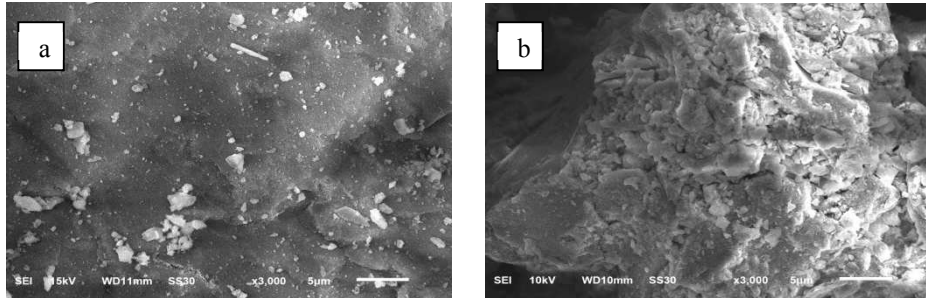


Fig. 2 SEM image of (a) CuFe_2O_4 and (b) bentonite- CuFe_2O_4 composite.

Adsorption of Ni(II). Weight of adsorbent is an important parameter for the determination of adsorption capacity of Ni(II). Fig. 3. showed the effect of weight of bentonite- CuFe_2O_4 composite on the adsorption capacity to Ni(II). The adsorption capacity decreased with the increase the weight of composite. Increasing weight of composite reduces unsaturation of the adsorption sites, so the number of such sites per unit mass down resulting in comparatively less adsorption.

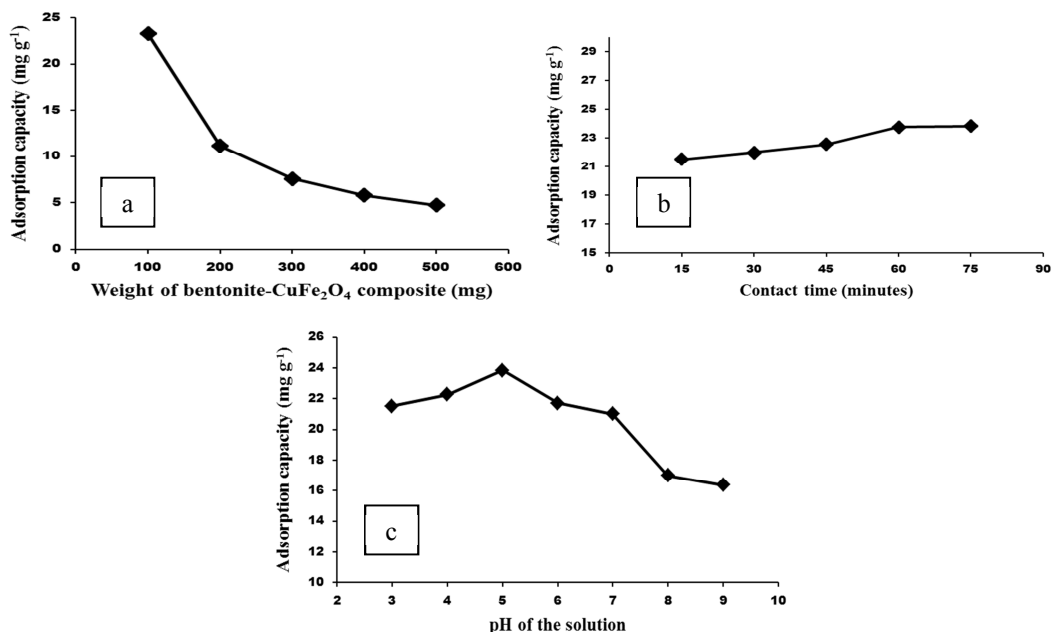


Fig. 3 Effect of (a) weight of bentonite- CuFe_2O_4 composite (b) contact time and (c) pH.

The effect of contact time on the adsorption capacity of Ni(II) by bentonite- CuFe_2O_4 composite that the adsorption process divided into two steps. The adsorption capacity increases regularly from 15 to 60 minutes and the adsorption capacity has a constant value at 60 minutes. Optimum of contact time adsorption Ni(II) onto modified (*Eriobotrya japonica*) loquat bark at 30 minutes [2], by pyrophosphate modified bentonite at 120 minutes [12] and using ceralite IR 120 was attained within 35 minutes [13]. It is clear that adsorption capacity dependent contact time.

The pH value affects the surface charge of adsorbent. To determine the optimum pH condition for the adsorption Ni(II) onto composite investigated by initial concentration of Ni(II) 50 mg L^{-1} , weight of composite 100 mg and contact time 60 minutes. The optimum pH for adsorption of Ni(II) was found to be 5. From Fig. 3 (c) showed that adsorption capacity increased with increase pH from

3 to 5. At the low pH there is competition between H^+ and Ni(II) for the ion exchange with Ca or Na ions in the bentonite. Adsorption capacity decreased after pH 5 because at higher pH of the solution the metal cation begin to hydrolyze and precipitate so became not available to adsorption.

The optimum conditions were obtained which weight of composite 100 mg, contact time of 60 minutes and the pH of the solution 5 was applied to adsorb Ni (II) from electroplating wastewater. Initial concentration of Ni(II) from electroplating wastewater was 5.289 mg L^{-1} and after treatment using bentonite- CuFe_2O_4 into 0.061 mg L^{-1} with adsorption efficiency 99.136 %. The result is greater compared adsorption Ni(II) from electroplating wastewater using pyrophosphate modified bentonite was 88.74 % [12].

Summary

Bentonite- CuFe_2O_4 composite have been proven to be an effective adsorbent for removal Ni(II). The optimum condition for adsorption was attained at weight of bentonite- CuFe_2O_4 composite 100 mg, contact time 60 minutes and pH of solution 5. The result showed the use of bentonite- CuFe_2O_4 composite an alternative adsorbent for treatment electroplating wastewater.

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References

- [1] E. Bernard and A. Jimoh, Adsorption of Pb, Fe, Cu, and Zn from Industrial Electroplating Wastewater by Orange Peel Activated Carbon, *Int. J. Eng. Appl. Sci.* 4 (2013) 95-103.
- [2] M.S. Nida and A.M. Awwad, Biosorption of Ni(II) from Electroplating Wastewater by Modified (*Eriobotrya Japonica*) Quat Bark, *J.Saudi Chem. Soc.* (2011) 1-8.
- [3] J.W. Patterson, *Industrial Wastewater Treatment Technology*, Butterworth Publisher, 1985
- [4] EPA 822-R-94-001, Drinking Water Regulations and Health Advisories, United State Environmental Protection Agency, 2004.
- [5] N. Kannan and G. Rengasamy, Comparison of Cadmium Ion Adsorption on Various Activated Carbons. *Water Air Soil Poll.* 163 (2005) 185-201.
- [6] D. Rafi, P.A.J. Antony, K.K. Anoop, K.V. Alex and R. Rajesh, Adsorption of Nickel(II) and Chrominum(VI) Ions by Chitin and Chitosan from Aqueous Solution Containing Both Ions. *Int. J. Sci. Tech. Res.* 1 (2012) 44-50.
- [7] J.L. Vega, J. Ayala, J. Loredo, and J. Garcia, I., Bentonite as Adsorbents of Heavy Metals Ion from Mine Waste Leachates: experimental data. 9th International Mine Waters Congress. (2005) pp. 603-609.
- [8] T. Martadipora, *Industrial Minerals in Indonesia*. Special publications. Directorate General of Natural Resource. Ministry of Energy and Mineral Resources. 1990.
- [9] J.T. Yao, C. F. You, C. K. Chang, S. L. Wang, and T. S. Chan, Arsenate Adsorption from Water Using a Novel Fabricated Copper Ferrite. *Chem. Eng. J.* 198-199 (2012) 440-448.
- [10] H. Saeedeh, Adsorption of Methylene Blue by Pistachio in Presence of CuFe_2O_4 nanocomposite. *Proceeding of the world congress on engineering and computer science, USA* (2010) Vol II:1-3.
- [11] S. Roy and J. Ghose, Superparamagnetic Nanocrystalline CuFe_2O_4 . *J. App. Phys.* 9 (2000) 6226-6228.
- [12] Sandeep, B.N, and S. Suresha, NPP-Modified Bentonite for Adsorption of Ni(II) from Aqueous Solution and Electroplating Wastewater. *Int. J. Environ. Sci.* 4 (2013) 113-122.
- [13] P. Senthil, K., K. Ramakhrisnan, and R. Gayatri, Removal of Ni(II) from Aqueous Solution by Ceralite IR 120 Cationic Exchange Resin. *J. Eng. Sci. Tech.* 2 (2010) 232-243.

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DOI References

- [5] N. Kannan and G. Rengasamy, Comparison of Cadmium Ion Adsorption on Various Activated Carbons. *Water Air Soil Poll.* 163 (2005) 185-201.
<http://dx.doi.org/10.1007/s11270-005-0277-y>
- [9] J.T. Yao, C. F. You, C. K. Chang, S. L. Wang, and T. S. Chan, Arsenate Adsorption from Water Using a Novel Fabricated Copper Ferrite. *Chem. Eng. J.* 198-199 (2012) 440-448.
<http://dx.doi.org/10.1016/j.cej.2012.06.006>
- [11] S. Roy and J. Ghose, Superparamagnetic Nanocrystalline CuFe₂O₄. *J. App. Phys.* 9 (2000) 6226-6228.
<http://dx.doi.org/10.1063/1.372662>