Fundamentals and Technology of Advanced Materials Course Syllabus

The course covers following topics:

Session & Time	Topic	Learning Outcome	Lecturer
08:00-10:00 Mon, 5 Aug 24	Functional Materials for Energy Conversion from Electrochemistry: • Fundamental concepts of Electrochemistry • Functional Materials for Energy Conversion (types and properties) • Applications of Functional Materials • Advances and Innovations	By the end of this course, participants are able to describe the fundamental concepts of electrochemistry. They can explain the different types of functional materials used in energy conversion, and their selection criteria based on properties like conductivity, stability, and efficiency. Participants can identify and discuss the role of functional materials in various applications. They are also able to analyze recent developments and future trends in the field, and engage in informed discussions about the potential and significance of functional materials in electrochemical energy conversion.	Dr. Shibghatullah Muhammady (Institut Teknologi Bandung, Indonesia)
14:00-16:00 Mon, 5 Aug 24	Graphene & CNT grown by Plasma Enhanced Chemical Vapor Depostion Method: • Fundamentals of Graphene and Carbon Nanotubes • Plasma Enhanced Chemical Vapor Deposition (PECVD) • Growth of Graphene and CNTs Using PECVD. • Applications and Future Trends	By the end of this course, participants are able to describe the properties and atomic structure of graphene and carbon nanotubes, and explain the principles and advantages of Plasma Enhanced Chemical Vapor Deposition (PECVD). They can detail the step-by-step PECVD processes for growing graphene and CNTs, including key parameters and optimization factors. Participants are able to identify specific	Prof. Dr. Toto Winata (Institut Teknologi Bandung, Indonesia)

		applications of PECVD-grown graphene and CNTs in various industries, discuss emerging trends and future research in PECVD technology, and engage in informed discussions about the future and potential of PECVD in nanomaterials.	
08:00-10:00 Wed, 7 Aug 24			Prof. Andrivo Rusydi., Ph.D. (National University of Singapore)
14:00-16:00 Wed, 7 Aug 24	Nanomaterials and Beyond • Definition and properties of Nanomaterials • Synthesis and fabrication of nanomaterials • Applications of nanomaterials • Nanomaterials in the future • Some case studies	By the end of this course, participants are able to describe the properties and types of nanomaterials, explain synthesis and fabrication methods, and identify key applications in medicine, electronics, and energy. They can discuss emerging trends, evaluate environmental and ethical considerations, and analyze real-world case studies. Participants are also prepared to engage in informed discussions about the future of nanomaterials, demonstrating a comprehensive understanding of the subject.	Dr.rer.nat. Akfiny Hasdi Aimon (Institut Teknologi Bandung, Indonesia)
14:00-16:00 Tue, 6 Aug 24	Drops dance and explode on lubricated surfaces: • Background and Traditional Methods of Coulomb explosions	By the end of this course, participants are able to describe traditional and novel methods for observing Coulomb explosions, explain the experimental setup and observations using the	Dr. Dan Daniel (King Abdullah University of Science and Technology)

	• New Approach to Observing Coulomb Explosions • Coulomb Explosions in Sessile Drops • Influence of External Electric Fields • Potential applications	new method, and discuss the influence of small external electric fields on jetting direction. They can analyze the diverse length and time scales of Coulomb explosions and identify potential applications in nanoscopic material fabrication and electrospray ionization. Participants are also prepared to engage in informed discussions about the implications and future research directions of this novel observation method.	
08:00-10:00 Thu, 8 Aug 24	Semiconductor - based Photocatalyst: Challenges and Opportunities: • Principles of photocatalysis • Semiconductor Materials for Photocatalysis-properties and characteristics • Challenges in Semiconductor-Based Photocatalysis • Opportunities and Advances in photocatalytic materials	By the end of this course, participants are able to describe the principles and mechanisms of photocatalysis, identify common semiconductor photocatalysts and their properties, and discuss the challenges associated with their efficiency, stability, and scalability. They can also analyze recent advances and opportunities in the field, including innovative applications and future research directions, and engage in informed discussions about the potential and challenges of semiconductor-based photocatalysts.	Dr. Osi Arutanti (Research Center for Chemistry, National Research and Innovation Agency)
14:00-16:00 Thu, 8 Aug 24	Novel materials for Next Generation Solar cells: • Basic Principles of Solar Energy Conversion • Traditional vs. Novel Solar Cell Materials	By the end of this course, participants are able to describe the basic principles and types of solar cells, including traditional and novel materials. They can identify the advantages and challenges of novel materials such as	Prof. Lydia Wong (Nanyang Technological University)

	• Advantages and Challenges of Novel Materials- Perovskite solar cells, Quantum dot solar cells, Organic photovoltaic cells (OPVs), Dye-sensitized solar cells (DSSCs). • Advances and Future Directions	perovskites, quantum dots, organic photovoltaics, and dye-sensitized solar cells. Participants are also able to discuss recent advancements and future directions in solar cell technology, and engage in informed discussions about the potential and challenges of next-generation solar cells.	
14:00-16:00 Fri, 9 Aug 24	Artificial Intelligence for Battery (tentative): • Fundamentals of Battery Technology- Basic principles and key performance indicator • Introduction to Artificial Intelligence (AI) • AI Applications in Battery Technology- design, management system, and quality control. • Case Studies and Recent Advances	By the end of this course, participants are able to describe the basic principles of battery technology and key performance metrics. They can explain fundamental AI concepts and their applications in engineering. Participants are able to identify and discuss how AI is used in battery development, management systems, and manufacturing. They can also analyze real-world case studies and emerging trends, and engage in informed discussions about the potential and challenges of AI in advancing battery technology.	Dr.Eng. Muhammad Syafrudin (Sejong University, Korea)
08:00-10:00 Mon, 12 Aug 24	From Structural Ceramics to Multifunctional 2D Materials: Evolution from MAX Phases to MXenes: • Fundamentals of Structural Ceramics • Introduction to MAX Phases and its applications • Evolution from MAX Phases to MXenes • Multifunctional	By the end of this course, participants are able to describe the fundamentals of structural ceramics and their properties, explain the concept of MAX phases and their applications, and understand the evolution from MAX phases to MXenes. They can identify the properties and applications of MXenes, including their	Pipit Fitriani, Ph.D (Institut Teknogi Bandung)

	Capabilities of MXenes	multifunctional capabilities and recent advancements in research. Participants are also prepared to engage in informed discussions about the future potential and challenges of MXenes and their impact on material science.	
14:00-16:00 Mon, 12 Aug 24	Critical minerals-based advanced materials: Global outlook, value chain, and key strategies for industrial development: • Definition and importance of Critical Minerals • Global Outlook on Critical Minerals-market, demand trends, political and economic factors. • Key Strategies for Industrial Development	By the end of this course, participants are able to describe what critical minerals are and their importance in advanced materials. They can explain the global outlook, including market trends and geopolitical factors affecting critical minerals. Participants are able to outline the value chain from exploration to end-use applications and discuss key strategies for industrial development, including supply chain resilience, technological advancements, and policy considerations. They are also prepared to engage in informed discussions about the future challenges and opportunities in the field of critical minerals and advanced materials.	Dr. Aditya Farhan Arif (Mining Industry Indonesia)
08:00 – 10:00 Tue, 13 Aug 24	Crystal Structure Modulation of Energy Conversion Oxide Electrolytes: • The Fundamentals and The Role in Energy Conversion • Crystal Structures of Oxide Electrolytes • Modulation Techniques	By the end of this course, participants are able to describe the basics of oxide electrolytes and their role in energy conversion devices. They can explain how different crystal structures impact the properties and performance of oxide electrolytes. Participants are familiar with various techniques for	Dr. Stevin Pramana (Newcastle University, UK)

	• Applications in Energy Conversion Devices (Fuel cells, battery, and other devices).	modulating crystal structures, such as doping, strain engineering, and nanostructuring, and can analyze case studies demonstrating the benefits of these techniques. They understand the applications of modulated oxide electrolytes in fuel cells, batteries, and other energy conversion devices and can engage in informed discussions about the potential and challenges of crystal structure modulation.	
14:00-16:00 Tue, 13 Aug 24	Bond order redefinition needed to reduce inherent noise in molecular dynamics simulations: • Basics of Molecular Dynamics Simulations-fundamentals and role of bond order • Challenges with Traditional Bond Order Definitions-inherent noise and limitations • Redefining Bond Order • Case studies and applications.	By the end of this course, participants are able to describe the fundamentals of molecular dynamics simulations and the role of bond order. They can identify the challenges and limitations of traditional bond order definitions and understand the need for redefinition to reduce inherent noise. Participants are able to explain the proposed redefinitions, their implementation, and their impact on simulation accuracy. They can analyze case studies and discuss the potential benefits and challenges of adopting new bond order definitions in molecular dynamics simulations.	Dr. Ibnu Syuhada (Yayasan Cahaya Putra Ilmu)

08:00 – 10:00 Wed, 14 Aug 24	Density functional theory for nanomaterials development: • Basics of Density Functional Theory-fundamental concepts and methods/approximations • Applications of DFT in Nanomaterials • Case Studies and Examples • Future Directions and Innovations-advances and emerging trends	By the end of this course, participants are able to describe the fundamental concepts of Density Functional Theory (DFT) and its applications in nanomaterials development. They can explain how DFT is used to optimize nanomaterial structures, predict electronic properties, and study surface interactions. Participants are also able to analyze case studies where DFT has been applied to nanomaterials, discuss the challenges and limitations of DFT, and explore future advancements and innovations in the field.	Dr. Erik Bhekti Yutomo (Universitas Diponegoro)
08:00-10:00 Thu, 15 Aug 24	MFS (Al/BaxSr1-xTiO3/Si) structure and its application for ferroelectric sensors: • Basics of MFS Structures-overview and properties • Ferroelectric Materials and Their Properties • MFS Structure Fabrication and Characterization methods. • Applications of MFS Structures in Ferroelectric Sensors	By the end of this course, participants are able to describe the MFS ($Al/Ba_xSr_{1-x}TiO_3/Si$) structure and understand the role of each layer. They can explain the properties and behavior of $Ba_xSr_{1-x}TiO_3$ as a ferroelectric material and its integration with Al and Si in the MFS structure. Participants are also able to discuss fabrication techniques, characterization methods, and applications of MFS structures in ferroelectric sensors, including real-world examples and case studies. They can engage in informed discussions about the potential and challenges of using MFS structures for various sensing applications.	Prof. Irzaman (Institut Pertanian Bogor)

14:00-16:00 Thu, 15 Aug 24	Physics mindset to develop farmers in villages (holistic approach: science, technology, business, social): • Physics Mindset and Its Relevance • Scientific Approaches to Farming • Technological Integration-tools, techniques, and efficiency • Business and Economic Aspects • Social and Community Development	By the end of this course, participants are able to describe how a physics mindset can be applied to agricultural development, integrating scientific, technological, business, and social aspects. They can explain basic scientific principles relevant to farming, identify technological tools and their applications, and understand economic factors and business models for farmers. Participants are also able to discuss the role of social infrastructure and sustainable practices in holistic farming development. They can engage in informed discussions about the benefits and challenges of implementing these approaches in rural farming communities.	Dr. Ahmad Fauzi (Pusat Penelitian Kelapa Sawit-RPN)