

Advanced Materials

Sector Roadmap
2014-2017

Materials for Sensors

Priority Areas

| 2014 | 2015 | 2016 | 2017 |
|--|--|---|--|
| Synthesis of Sensor Materials (e.g. SMAs) | Sensor Design Using New Materials | Fabrication of Smart Sensors for Various Applications (e.g. heavy metal detection, high temperature SMA sensors to detect incidence of overheating/high temperature excursions) | Deployment, Evaluation, Testing Studies and Possible Scale Up Studies to Make Suitable for Large Scale Production |
| Sensors - Materials Development Potentiometric, Amphoteric, Photometric, Colorimetric, Spectroscopic, Thermochromatic sensors | Sensors - Device Design Demonstration (sensitivity, selectivity, reliability) Potentiometric, Amphoteric, Photometric, Colorimetric, Spectroscopic, Nitinol as sensing and actuating material | Sensors - Lab-scale Prototype Demonstration (scalability) Potentiometric, Amphoteric, Photometric, Colorimetric, Spectroscopic, Piezoelectric stretching sensor | Sensors - Lab-scale Prototype Demonstration (field deployable, integration) Potentiometric, Amphoteric, Photometric, Colorimetric, Spectroscopic, Touch sensitive material sensor |
| Sensors for Health, Water, Air, Soil, Food | | | |

2014

2015

2016

2017

Chemical Sensors for Mine Site Monitoring Program

Project 1. Mapping of Heavy Metal Contamination in the Philippine Mining Soils Using Laser-induced Breakdown Spectroscopy (LIBS) Field Sensors

Project 2. Optical Sensors for the Determination of Zn and Cu in Ambient Water

Project 3. Gaseous Elemental Mercury Sensors for Atmospheric Monitoring

Project 4. Integrated Sensing System Using Mobile and Cloud Technologies for Mining and Nearby Communities

Project 5. Data Integration and Visualization of Sensor Output for Mine Site Monitoring

MECO-TECO: Synthesis and Characterization of Novel Metal Nanoparticle-doped Electroactive Polymer Materials and Their Possible Application for Gas Sensing

2014

2015

2016

2017

Sensors for Agricultural and Fishery Ecosystems and Harvests Safety (SAFEHarvestS) Program

Project 1. Development of Portable Surface Plasmon Resonance MIP-based Sensor for Detection of Histamine in Shrimps

Project 2. Development of Sensitive Prototype Sensor for Monitoring Insecticide Residues in Fruits and Vegetables to Address Current MRLs

Project 3. Development of Potentiometric-MIP Test Kit for the Detection of Clenbuterol in Meat

Project 5. The Development of Portable Detection Systems for Nitroimidazoles in Hog Urine and Piggery Run-off Water

Project 6. Molecularly Imprinted Polymer Modified-Carbon Paste Electrodes (MIP-CPEs) as Multi-analyte Sensor for the Detection of Organophosphorus Pesticides Chlorpyrifos and Fenitrothion and Triazine Herbicide Atrazine

Project 4. Development of Electrochemical Sensor Platform for Meat and Fish Freshness Monitoring

Coatings *(PVD and Plasma, Thermal Spray and Electrodeposition)*

Priority Areas

| 2014 | 2015 | 2016 | 2017 |
|--|--|---|---|
| PVD Machine and Process for Surface Modification of Various Materials | Characterized MAX Phases for Decorative Colors and Functional Materials on Metal, Polymer, Alloy, Glass Substrates | Adherent Adhesive-free Metal Films on Surface Modified Polymers | Optimized and Robust Coating Processes for Various Applications |
| | | Pulse Plating of Chrome and/or Alloy Coatings | Studies on Metal-oxide Composite Coatings via Electrodeposition |
| Heat Resistant Coated Materials | Antimicrobial Coated Materials | Self-cleaning Coated Materials | Anti-foul Coated Materials |
| Metallic Composite Coating by Electrodeposition for Structural/Industrial Applications | | | Pilot Scale Metallic Inorganic/Alloy Coating by Electrodeposition |
| Electrophoretic Superconducting Materials Coating | Large Area Electrophoretic Superconducting Coating | | Superconducting Structures for Magnetic Shielding |

Coatings *(PVD and Plasma, Thermal Spray and Electrodeposition)*

Actual Projects

2014

2015

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2017

Development of a Low-Energy Ion Source System for the Synthesis of Diamond-like Carbon Films

**Physical Vapor Deposition of
Advanced MAX Phase
Materials**

**Fabrication of Metal Oxide
Thin films for Optical Coatings
with Plasma Assisted
Deposition Using a Plasma
Enhanced Chemical Vapor
Deposition (PECVD) System**

**High Throughput Processing
of Functional Thin Films Using
Gaseous Discharges**

Project 1. Development of Direct Current (DC) Magnetron Plasma System for Ti-Al-C Thin Film Synthesis

Project 2. Development of Radio Frequency (RF) Plasma System for Ti-Al-N Thin Film Synthesis

Advanced Polymers, Fibers, and Composites

Priority Areas

| 2014 | 2015 | 2016 | 2017 |
|--|--|--|--|
| Indigenous Materials Properties Characterization | Processing of Composites for Target Applications | Optimization Studies and Prototyping for Novel Applications | New Applications for Natural Fiber-reinforced Composites |
| Biodegradable Polymers for Packaging | Antimicrobial Fibers | Surface Modified Conducting Polymers Using Ion Shower System | |
| | Plasma Treated Abaca Natural Fiber Composite for Industrial Applications (R&D) | Plasma Treated Abaca Natural Fiber Composite for Industrial Applications (Prototype product) | |
| Conducting Polymers for Solar Cell Applications | Ion-conductive Polymer Metal Composite Materials | Quantum Tunneling Composite Materials | Flexible Electronics |
| | Polymer for Fuel Cell Application | Polymer for Drug Delivery | |

Green Materials and Remediation

Priority Areas

2014

2015

2016

2017

Develop and Characterize **Materials to Detoxify Harmful Substances in Water, Air, and Soil**

Membrane-based System for Water Treatment

Polymer for Environmental Application

Materials and Processes for Desalination

Removal and Decomposition of Water-soluble Oil Fraction by Photocatalysis

Development of Zeolite for Oil Spill Decontamination

Mineralization of CO₂ and Other Pollutants in the Atmosphere Using Mine Tailings and Other Mineral Sources for Cement Production

Development of Calcium Carbonate-chitosan Composite Membrane for Spill Treatment

Characterization of Carbonized Chicken Feathers for Hydrogen Storage, Heavy Metal Absorption, and Gas Cleaning System

Green Materials and Remediation

Actual Projects

2014

2015

2016

2017

**Development,
Characterization and
Performance Evaluation
of Polymeric Separation
Membrane for Industrial
Applications using Local
Materials (Phase 1)**

Electronics and Semiconductor Materials

Priority Areas

2014

2015

2016

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Semiconductor Materials

PN Diode (silicon, polysilicon, III-V), Schottky Diode (ZnO, TiO₂, Si, Ge), Heterojunction Diode (ZnO/Si, CuO/ZnO), Field Emission Transistor (III-V compound, spin, tunneling, ferro-electric)

Materials Development

Device Demonstration

Logic Circuit Demonstration

Electronics Device Fabrication

Contacts and Interconnects, Barriers and Dielectrics, Doping, Packaging, Deposition, Optoelectronics

Materials and Process
Development

Process Demonstration:

| | |
|----------------------------|--------------------------------------|
| Contacts and Interconnects | Industry compatible |
| Barriers and Dielectrics | Ultra thin barrier, low-k dielectric |
| Doping | Selective |
| Packaging | Thermal management polymer |
| Deposition | Printed electronic devices |
| Optoelectronics | Cost-effective, power-efficient LEDs |

Electronics and Semiconductor Materials

Priority Areas

2014

2015

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Organic Semiconductor Materials

Synthesis

Characterization

Prototype

Creation of New Organic
Materials

Material Recovery

Characterization of Metal
Components of Typical
Electronics and Semiconductor
Waste

Recovery of Cu in Powder Form
From Liquid Waste of Printed
Circuit Board Facilities

Recovery of Metals in Powder
Form From Solid Waste of the
Electronics and Semiconductor
Industry

Utilization of Recovered Metal
Powder for Various Applications

Superconducting Materials

Device Grade Superconducting
Films

Thin Film Superconducting
Device

Magnetic Imaging Device

Electronics and Semiconductor Materials

Actual Projects

2014

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**Angular Goos-Hanchen
Shift: An Optical
Phenomena for Ultra Thin
Film Thickness
Measurement**

**Conduction in Disordered Materials in the Low-Frequency
Region**

**Fabrication of Highly C-Axis
Oriented YBCO Thin Films
by Sedimentation
Deposition**

**Ultrafast MBE-grown
Terahertz Photoconductive
Antenna Devices**

Materials for Energy

Priority Areas

2014

2015

2016

2017

Superconductors

Basic Studies

Loss Studies in Superconducting Wires and Tapes

Superconducting Wires

Superconducting Transformer

Equip Labs to Characterize and Test Materials for Energy

Studies on Synthesis of Porous Metals

Local Studies on Liquid Electrode Material Systems (e.g. Mg and Sb)

Photovoltaics

Materials Development
a) DSSC cost-effective dyes, environment safe electrolyte, transparent electrode
b) Alternative materials and processes - focus on low cost, environment friendly, scalability

Device Demonstration From Developed Materials and Processes

Prototype Device Demonstration

Cost-competitive DSSC

Materials for Energy

Priority Areas

2014

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Silicon

Materials and Process and Testing Development

- a) Monocrystalline Si-PV - low cost processing at least 15% efficiency
- b) Polycrystalline Si-PV - low cost processing at least 10% efficiency
- c) Amorphous Si-PV - low cost processing at least 5% efficiency

Device Demonstration From Developed Materials and Processes

Prototype Device Demonstration

Cost Competitive Solar Cells Bulk

Alternative and Renewable

Materials Development

- a) thermoelectric
- b) piezoelectric
- c) salinity-gradient
- d) light weight wind-turbine material,
- e) corrosion resistant water turbine material

Device Demonstration From Developed Materials and Processes

Prototype Device Demonstration

Practical-scale Device Demonstration

Zeolite Filled Composite Membrane for Biogas Quality Improvement

Materials for Energy

Priority Areas

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Energy Storage Devices

Materials Development

- a) Supercapacitors - electrolytes, membranes, electrodes
- b) Hydrogen production - light induced hydrolysis
- c) Liquid batteries - electrolytes, membranes, electrodes
- d) Lightweight batteries - solid polymer electrolytes, membranes, porous electrodes

Device Demonstration From Developed Materials and Processes

Prototype Device Demonstration

Practical-scale Device Demonstration

Others

Plastics for Solar Cells

Supercapacitors for Photovoltaics

Superconducting Transformers

Materials for Energy

Actual Projects

2014

2015

2016

2017

A Graphene-Based Electrochemical Supercapacitor for Solar Cells

Fabrication of a Solid-State Rechargeable Li-ion Battery Using $\text{Li}_7\text{La}_3\text{Zr}_2\text{O}_{12}$ as Solid Electrolyte for Energy Storage Applications

e-Asia JRP: Development of Functional Nanocarbon-Based Catalysts for Biomass Conversion Processes

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Biodegradable Materials

Testing of Biodegradable Packaging Materials: Materials Sources

Fabrication and Testing of Biodegradable Materials

Biodegradable Starch-based Packaging Films for Food Products

Biodegradable Polymers and Composites

Inhibitors

Moisture Inhibitor Materials

Corrosion Inhibitor Materials

Oxygen Absorber Materials

Packaging Materials/ Technology for Agricultural and Food Products

Actual Projects

2014

2015

2016

2017

**Development of a Cost-Effective Colorimetric
Packaged/Frozen Fish Freshness Sensor Using Food-
Compatible Materials**

Fabrication of Supercapacitors Using Indigenous Textiles as Electrode Materials

Biomaterials

Priority Areas

| 2014 | 2015 | 2016 | 2017 |
|---|---|--|--|
| Studies on Local Raw Materials | Carbonate Apatite Coating Synthesis | Process Optimization Studies | Bioactive Material for Orthopedic Applications |
| | Hydroxy Apatite (HAp) Synthesis and Characterization | | Material for Sutures and Wound Dressings |
| Biopolymers for Skin Graft | | Biopolymers for Bone Remediation | |
| Studies on Local Raw Materials for Biocompatibility | Synthesis of Biopolymers Carbonate Apatite Coating Synthesis | Characterization of Biopolymers Biomaterials for Drug Applications | Polymer for Bio Mimicking |

Computational Materials

Priority Areas

2014

2015

2016

2017

Construction of Database

Reported Material Properties of Selected Strategic Materials Relevant to the Local Industry

Focuses on Changes in Microstructure of Strategic Metals/Alloys

Advanced Materials Design

Training on Computational Methods in Advanced Materials Design
New computing methods, Set up of computing workstations

Special Applications to Advanced Materials Design
Cloud-based Computing Technologies

Special Applications to Advanced Materials Design
Application to Key Target Areas

Competency for Advanced Materials Design

Computational Materials Design

For Biofuel Production

For Hydrogen Storage

For Hydrogen Fuel Cell

For Drug Delivery

Emerging Fabrication Competency

Priority Areas

2014

2015

2016

2017

Preparation for Fab
Facility

Construction of
Cleanroom

Equip Fabrication

Center for Advanced
Materials Design and
Fabrication

Emerging Fabrication Competency

Actual Projects

2014

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2016

2017

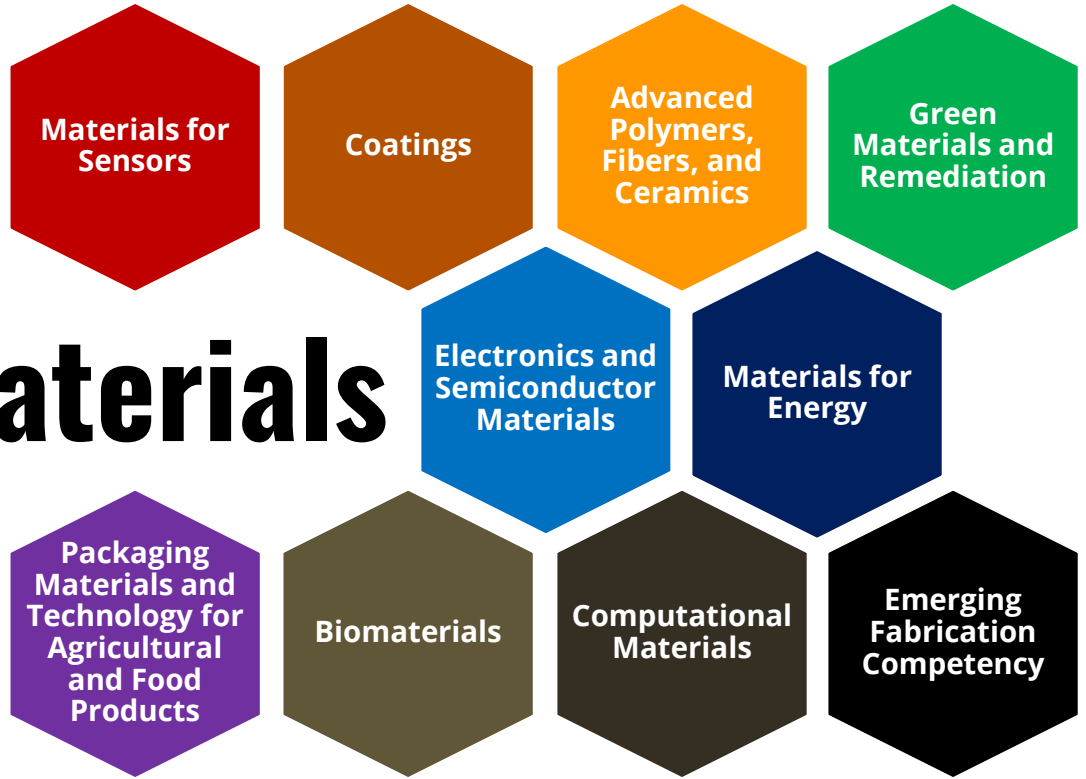
**Establishment of an Advanced Device and Materials Testing Laboratory
(ADMATEL)**

**Sustainability of
ADMATEL for the
Semiconductor and
Electronics and Other
Related Industries**

**Development of Physarum Polycephalum Powered
Actuators for a Microfluidic Mixer**

Project 1: Development of a Microgear Actuator Powered by
Physarum Polycephalum

Project 2: Development of a Hybrid Physarum Polycephalum
Controlled Micro-valve



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