

Nanotechnology Initiatives and Prospects in the Philippines

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DOST-PCIEERD

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DEPARTMENT OF SCIENCE AND TECHNOLOGY
PHILIPPINE COUNCIL
FOR INDUSTRY, ENERGY,
AND EMERGING TECHNOLOGY
RESEARCH AND DEVELOPMENT
(DOST-PCIEERD)

Sequoia Hotel, Quezon City

INNOVATION COUNCIL
FOR INDUSTRY, ENERGY AND EMERGING TECHNOLOGIES (DOST-PCIEERD)

Who is DOST-PCIEERD?



The **Philippine Council for Industry, Energy, and Emerging Technology Research and Development (PCIEERD)** is one of the three sectoral planning councils of the Department of Science and Technology (DOST).

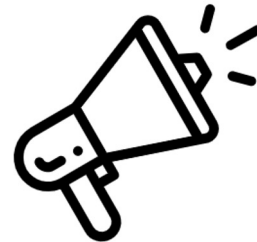
Our Mandate



Support for Research and Development



Human Resource and Institution Development



S&T Information Dissemination and Promotion



Support for Technology Transfer and Commercialization



Policy Development and Advocacy



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INNOVATION  COUNCIL
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VISION

By 2040, PCIEERD is the Nexus of Innovation, the leading contributor to the nation's productivity and competitiveness by enabling Science and Technology solutions in the industry, energy sectors, and emerging technologies, while upholding the tenets of good governance.

MISSION

Provide strategic leadership in enabling innovation in industry, energy sectors and emerging technology
PCIEERD commits to:

- Formulate national policies, plans, programs, and strategies for S&T development in the industry, energy and emerging technology sectors;
- Allocate government and generate external funds for research and development
- Manage STI programs and projects implemented and supported by the Council towards utilization and adoption

Our Sectoral Coverage

INDUSTRY



Electronic & Semiconductor Industries



Mining & Minerals



Metals & Engineering



Food Processing



Process



Energy efficiency



Transportation

EMERGING TECHNOLOGY



Materials Science/
Nanotechnology



Genomics/
Biotechnology



Information & Communications Technology



Space Technology Application



Photonics



Artificial Intelligence



Data Science



Creative Industries

SPECIAL CONCERNS



Climate Change Adaptation



Disaster Risk Reduction & Management



Environment



Human Security



2022 Notable Accomplishments

P712,480,000 (PCIEERD-GIA)

total funding amount for 2022

P 1,685,514,580 (DOST-GIA)

total funding amount for 2022



106

Completed Projects



11

COVID-related projects



159

Funded Projects



381

Ongoing projects



409

Projects monitored



770

proposals received



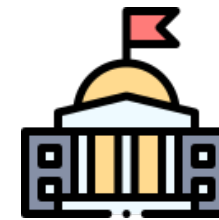
131

Project Leaders



86

HEIs



48

Partnerships



9

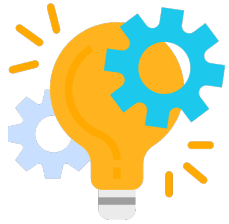
International Cooperation



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ETDD's 2022 Accomplishments



26

Completed Projects



28

New Projects Funded



49

Ongoing Projects



70

Proposals received & evaluated for CY2024



13

Approved Proposals for funding in 2024



7

New Project Leaders



2

New HEIs



6

National Government Agencies/ LGUs maintained



15

Non-Government & Private Organizations



10

Inputs to International Cooperation & Policies

2012-2015 Philippine Nanotechnology Roadmap

From Enriquez, 2017

Chapter 1: Introduction: Nanotechnology for the Philippines, co-authored by Dr. Fabian M. Dayrit and Dr. Erwin P. Enriquez, with the assistance of Christian A. Malapit

Chapter 2: Applications of Nanotechnology in Food and Agriculture, authored by Dr. Milagros Peralta with contributions from Dr. Veronica Sabularse, Dr. Fortunato Sevilla, and Dr. Antonio Laurena, and with the assistance of Ruby Janet Ortiz

Chapter 3: Natural Nanomaterials for Polymers and Composites, authored by Dr. Blessie A. Basilia, Marissa A. Paglicawan, Josefina Celorico, and Richard Clemente

Chapter 4: Applications of Nanotechnology in Energy, authored by Dr. Erwin P. Enriquez with contributions from Dr. Jim Josephus G. Minglana and Dr. Guillermo M. Nuesca, and with the assistance of Ian Harvey J. Arellano

Chapter 5: Applications of Nanotechnology in Biomedicine, authored by Dr. Cynthia Saloma

Chapter 6: Applications of Nanotechnology in ICT and Semiconductors, authored by Dr. Arnel Salvador with contributions from Dr. Roland Sarmago and Dr. Armando Somintac, and with the assistance of Michael Defensor and Athan Azares

Chapter 7: Applications of Nanotechnology to the Environment, authored by Dr. Fabian M. Dayrit and Dr. Christina A. Binag, and with the assistance of Christian A. Malapit

Chapter 8: Safety and Risk Assessment in Nanotechnology, authored by Dr. Fortunato Sevilla III

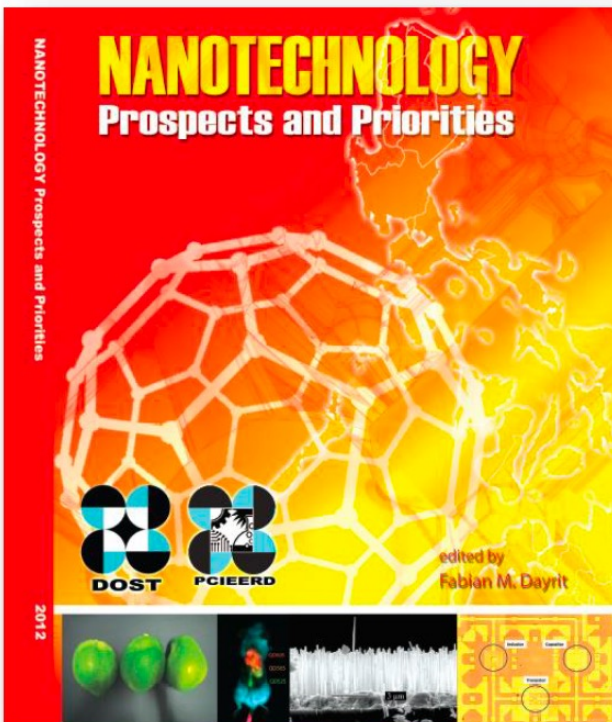
Chapter 9: Education and Metrology in Nanotechnology, authored by Dr. Fabian M. Dayrit and Dr. Erwin P. Enriquez

Chapter 10: A Roadmap for the Development of Nanotechnology in the Philippines, authored by Dr. Fabian M. Dayrit

Key Topics

- Food and Agriculture
- **Polymers and Composites**
- **Energy**
- Biomedicine
- **ICT & Semiconductors**
- **Environment**
- **Nanotechnology Risk**
- **Education**

| Health and Env'tl Risk | Local need | UN MDG | Existing Local capability | Funding needed |
|------------------------|-------------------|-------------------|---------------------------|----------------------|
| 5: Low 1: High | 5: High 1: Low | 5: High 1: Low | 5: High 1: Low | 5: Small 1: Large |



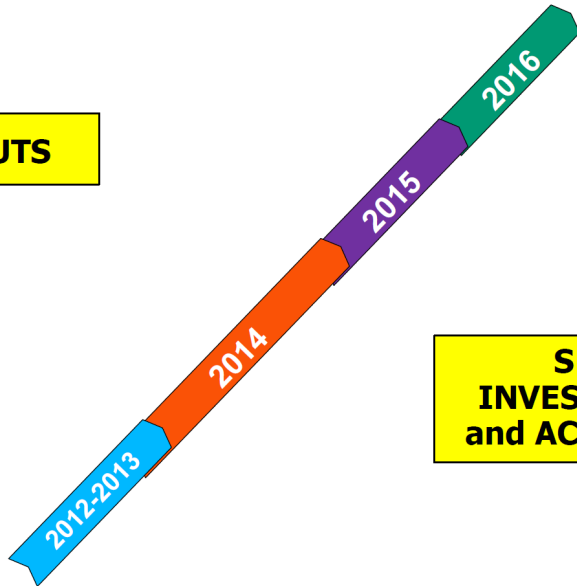
Roadmap was sustained

- *Round Table Discussion: Updating of Advanced Materials & Nanotechnology Roadmap (2017-2022) Crowne Plaza Manila Galleria, 28 September 2017*

A Competitive Philippine Industry and Agriculture Through Nanotechnology

OUTPUTS

S & T INVESTMENTS and ACTIVITIES



Nanotechnology R&D Roadmap (2012-2016)

Materials

- Nano-photocatalysts
- Nanosilica heat exchanger
- Nanocomposite
- Nanoclay-based materials

Electronic materials

- Nanolab at the MSD-ITDI
- HR-TEM facility
- DOST ADMATEL
- Fuel Cell applications
- Printed Electronics

Food and Agriculture

- Nanotech Center at UPLB
- Nanobiosensors
- Nanosensors
- Nano-standards for nutraceuticals
- Nanosilica
- Nanocellulose
- Nano-precipitated CaCO_3
- Nano-encapsulated
- Molecularly imprinted polymers
- Nanoliposomes

- Fullerene, Carbon Nanotubes, Graphene
- Solar Cell applications
- Supercapacitors
- Optoelectronics applications



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The DOST-SEI -ASTHRDP had a benchmarking of graduate programs and research in Materials Science and Nanotechnology across selected countries in Asia (2015-2017)

- National Taiwan University (NTU)
- Korea Advanced Institute of Science and Technology (KAIST)
- NANOTEC, Thailand
- Chulalongkorn University
- University Malaya
- University Putra Malaysia
- Institute of Materials Research and Engineering, Singapore (A-Star)



Advanced Materials and Nanotechnology Consultative Meeting on Call for Proposals & Nanotechnology Forum

February and March 2021

via Zoom Web Conferencing

Participants:

| | |
|-------------------------|-----------|
| Academe | 12 |
| <i>Balik</i> Scientists | 4 |
| Industry | 8 |
| PCIEERD | 10 |
| TOTAL | 34 |

IDENTIFIED PRIORITY TOPICS:

1. Smart Materials

- High temperature coatings for batteries, molten surfaces, and inhibitors for chemical and geothermal corrosion
- Coating for paper-/cellulose-based packaging

2. Materials Informatics

- Materials platforms and tools
- Materials development and processing
- Low-carbon society

3. Nanosafety Program

4. Materials for Energy

- Fuel Cells (single stack, polymer exchange membrane, deployment for energy generation and storage)
- Supercapacitors (non-platinum alternatives, pseudo-capacitors, EDCL, solid-state and high-capacity supercapacitors made of conductive polymers, nanometal oxides, lithium air)



PCIEERD NANOTECHNOLOGY ROADMAP



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Nanotechnology Roadmap

OVERALL STRATEGIES

- Facilities and Services**
- Continuous support for ADMATEL and PATHS Center
- Human Resources**
- Increase awareness of Advanced Materials and Nanotechnology in STEM curriculum, and in industry and among consumers
 - Send 10 researchers abroad to raise local talent to global standards by providing exposure and training in renowned research laboratories
 - Establish programs to obtain visibility into industry needs and open channels for collaboration (e.g. internships, immersions)
 - Introduce targeted training electives in Advanced Materials and Nanotechnology to promote employment readiness of graduates for certain industry applications
 - Balik Scientist Program to consolidate resources and lead R&D and collaboration efforts in the field (through Advanced Materials and Nanotechnology Hub)
 - Improve workforce preparation for opportunities with multinational partners

R&D Technologies

- Build and publish database with information regarding technology researches, publications, laboratories and equipment, and skills developed
- Partner with at least 10 entities for R&D applications and infrastructure co-development
- Materials Informatics R&D

S&T Policies

- Ensure communication of government policy incentives and benefits to stakeholders
- Deployment of Nanosafety Policies / Standards



10 M

- Nanofiber materials as food packaging;
- Nanomaterial composites for filter applications

2020

- Materials development
- Development of Nanomaterial safety protocols
- Developed capability on nanobiosensing

2021

- Development of capabilities in coatings and nano-enabled materials
- Development of Nanomaterial safety protocols

2023

- Coatings of nanomaterials (ex. nano-structured polymers) for lightweight & strength applications
- Nano-enabled materials from Natural/Indigenous raw materials and waste/by-products (bioplastics, nanocellulose, etc.)
- Nanosensors to detect emerging diseases and harmful substance
- Nanoscaffolds for medical applications
- Nanomaterial safety
- Nanomaterials for aerospace

2022

- Enhanced capabilities, functionalities and applications
- Enhancement and deployment of nanomaterials safety protocols (including nanocertification and nanolabeling)

2024

- Advanced capabilities, functionalities and applications

2025

- Materials development
- Enhanced capabilities in nanofabrication techniques
- Developed nano-enabled energy devices and smart energy systems
- Developed nanostructured aerogels

2026

- Materials development
- Deployed nano-enabled energy devices and smart energy systems
- Enhanced capabilities of developed nanostructured aerogels

2027

- Materials development
- Developed graphene-based nano-enabled devices/products

2028

- OVERALL OUTCOMES**
Locally-developed products and services intended for wide-range of applications

R&D SOLUTIONS

50 M

- Coatings of nanomaterials for lightweight & strength applications
- Smart packaging
- Strong and light-weight materials from nanocomposites, nanocerment, magnesium-alloys, etc.
- Nanodelivery- Applications
- Nanosensors – Applications
- Nanodiagnostic devices
- Nanotech-enabled solutions addressing climate change (eg. more efficient materials—light harvesting coatings, green technology, etc.)

500 M

- Nanofabrication techniques for electronics and materials manufacturing (NEMS, memorytech, blow spinning)
- Adoption of advanced materials such as intermetallics, nanoclays and smart fibers

300 M

- Nanodevice fabrication for drug delivery and diagnostics (nanobots)
- Agricultural detection of pathogens, pesticide residues and determination of crop quality

100 M

- Nanofabrication techniques for electronics and materials manufacturing (NEMS, memorytech, blow spinning)
- Adoption of advanced materials such as intermetallics, nanoclays and smart fibers
- Development of nanostructured materials for efficient energy conversion and storage devices
- Development of smart energy systems (nano engineering of highly efficient conductors and superconductors)
- Development of nanostructured aerogels (applications in insulation, energy and environment)
- Graphene R&D
- Nano-photonic materials

100 M

- Development of nanogenerators
- Development of blue nanotech (development of blue nanomaterials, applications in consumer electronics, CO2 to carbon nanotubes conversion)
- Nano Biomimicry (applications on wave and tidal energy, sensing, bioluminescent household and street lighting)
- Nanomaterials for efficient energy conversion and storage devices (hydrogen energy storage, solar energy conversion)
- Deployment of smart energysystems (nano engineering of highly efficient conductors and superconductors)
- Development of nanostructured aerogels (applications in insulation, energy and environment)
- Graphene R&D (applications in flexible electronics, solar energy. Sensors, bioimaging)
- Nano-photonic materials

50 M

- Assembly and deployment of Nanogenerators
- Blue nanotech systems (development of blue nanomaterials, applications in consumer electronics, CO2 to carbon nanotubes conversion)
- Nano Biomimicry (applications on wave and tidal energy, sensing, bioluminescent household and street lighting)
- Graphene-enabled consumer products (solar panels, flexible displays, sensors, imaging devices)

50 M

- Convergence of Nanotechnology and Big Data analysis
- Graphene-enabled consumer products (solar panels, flexible displays, sensors, imaging devices)

Legend
(Text Font):



NAST FORESIGHT

VISION

Provision of enabling technologies for applications beneficial to society.

OVERALL STRATEGIES

Facilities and Services

- Continuous support for ADMATEL and PATHS Center

Human Resources

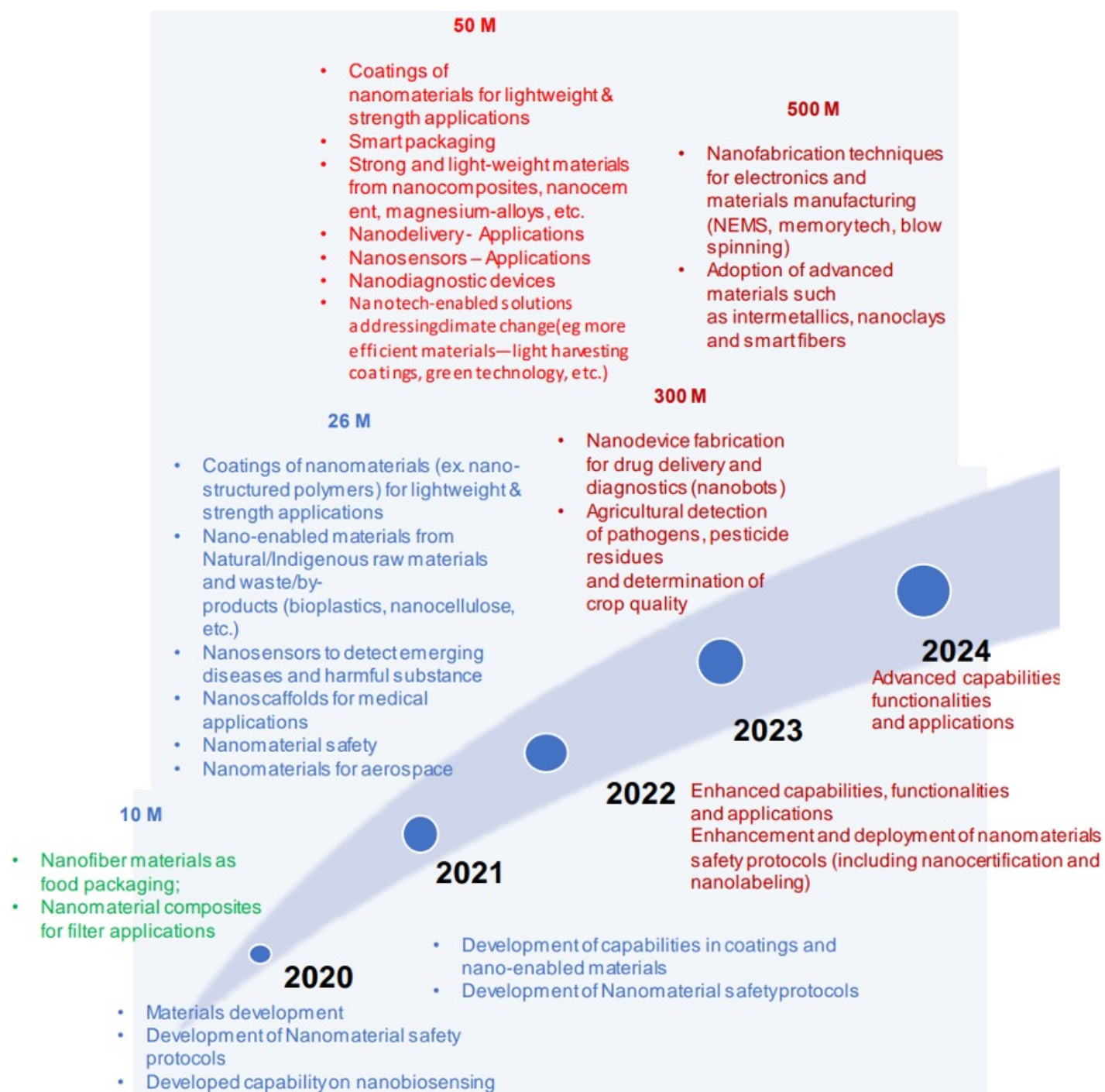
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- **Materials Informatics R&D**

S&T Policies

- Ensure communication of government policy incentives and benefits to stakeholders
- Deployment of Nanosafety Policies / Standards



Advanced Materials and Nanotechnology Focus Group Discussion

March 19, 2023

Participants:

| | |
|-------------------------|-----------|
| Academe | 26 |
| <i>Balik Scientists</i> | 2 |
| Industry | 2 |
| PCIEERD | 14 |
| TOTAL | 44 |

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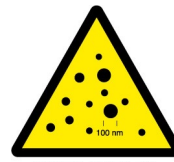
- Materials platforms and tools
- Materials development and processing
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NANO HAZARD

Nanomaterial safety

STRENGTHS

- Initial work done, headed by DOST - ITDI.
- Strong international linkage of the Phase I group with the International Nanosafety Group
- Initial capacity building facility and identification of local laboratories
- Initial protocols for standard testing
- Initial cytotoxicity testing
- Involvement in DTI-BPS TC₈₅

OPPORTUNITIES

- Identification of commercial applications of nanomaterials (particularly locally-produced)
- Development or innovation on protocols, products and process involving nanomaterials
- Establishment of standards
- Monitoring of commercial products (e.g., cosmetics, food)
- Promotion through nanoseal / nanolabelling
- Validation of commercial products claiming enhancement through nanotechnology
- Capacity building
- Establishment of facility for testing

WEAKNESSES

- No known local industry group specializing in nanosafety
- Not yet identified local products that use nanomaterials
- Lack of local and international standards in terms of products specifications

THREATS

- Limited capability in some technical aspect of testing and research on nanomaterials
- Possible negative perception
- Possible intrusion of false use of nanomaterials-authenticity problems
- Sustainability issues – availability, health and environmental impact



DOST- & PCIEERD-FUNDED / MONITORED SUPPORT FACILITIES



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UPLB NanoScience and Technology Facility Building



Budgetary Allocation from GAA: P52,000,000
(construction c/o DPWH)

Start Date of Construction: September 2020

Expected Date of Completion: December 2021

Total floor area: 794 sqm*

Analytical & Instrumentation Service Laboratory

(Equipment obtained with funding from  PCIIEERD-DOST)



Atomic Force Microscope

Brunauer - Emmett - Teller (BET) Physisorption Analyzer

Inductively Coupled Plasma - Optical Emission Spectrometer

Dynamic Light Scattering Size and Zeta Potential Analyzer



X-Ray Diffractometer (XRD)



Differential Scanning Calorimeter (DSC)

Ultra Performance Liquid Chromatograph with Diode Array Detector



Spectrofluorophotometer

Cyclic Voltammeter

B-90 Nano Spray Dryer

Fluorescence Microscope



Ultracentrifuge



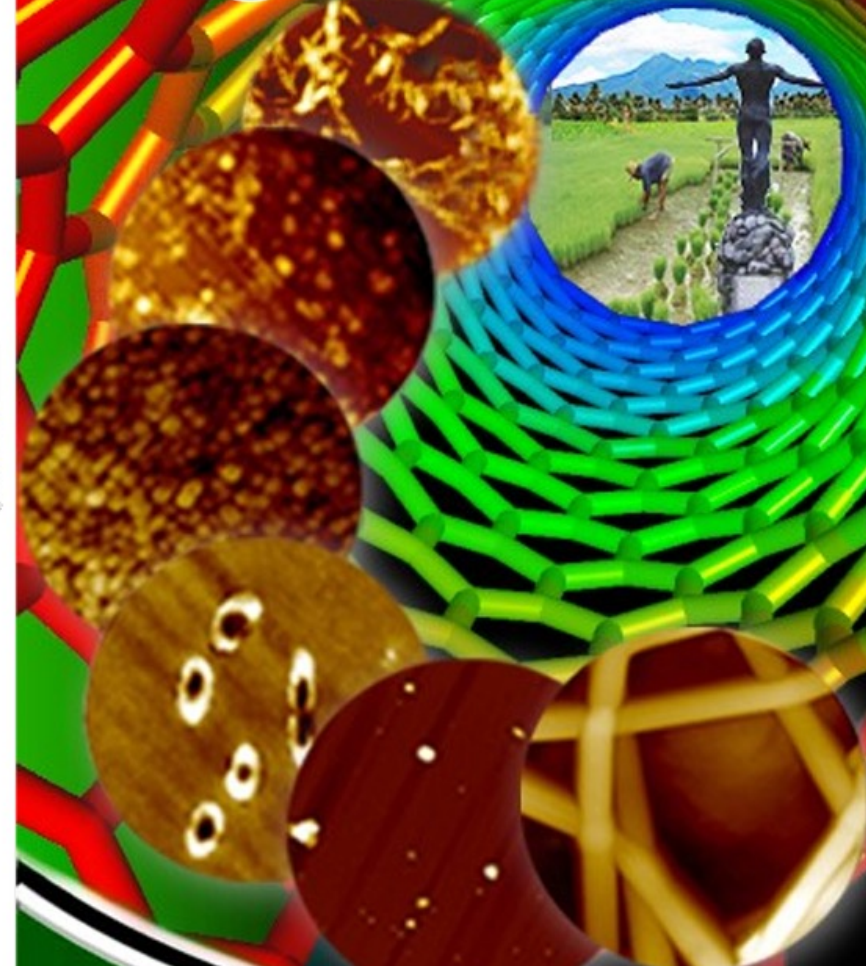
UV-Vis Spectrometer with Microplate Reader

Coperion Twin-Screw Multistage Extruder

GC-MS/MS Triple Quadrupole Analysis



UPLB Nanotechnology Program



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TECHNOLOGIES (DOST-PCIIEERD)



Advanced Device and Materials Testing Laboratory (ADMATEL)



YOUR PARTNER LABORATORY.

ADMATEL is a DOST national testing laboratory equipped with state-of-the-art analytical equipment for advance Failure Analysis and Materials Characterization. ADMATEL provides product quality test services that enable the local manufacturing industry and research community to leverage their global competitiveness in the market.

ISO/IEC 17025: 2017
ACCREDITED TESTING LABORATORY



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ADMATEL IS A PROJECT OF:



Department of Science & Technology (DOST)
Philippine Council for Industry, Energy and
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Industrial Technology Development Institute (ITDI)

IMAGING ANALYSIS

Using cutting-edge technology to obtain higher magnifications of the sample image capturing precise visuals and measurements down to the nanometer scale.



SURFACE ANALYSIS

We perform analytical tests focusing on the outermost layer of solid materials to determine elemental, molecular, and chemical state of the surface.



COMPOSITIONAL ANALYSIS

We provide accurate identification of sample makeup or chemical composition, be it in bulk or small in quantity.



THERMAL ANALYSIS

We help determine the thermal property and behavior of materials as it is being heated.



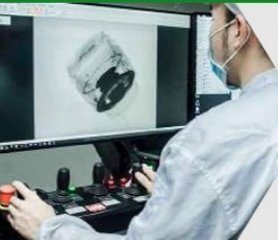
SAMPLE PREPARATION

We assist by utilizing industry methods for chemical preparation, precision slicing or cutting, decapsulation, and others.



3D X-RAY ANALYSIS

We conduct non-destructive inspection by using computed tomography to view the desired internal structures of the specimen through high-resolution 3D images.



OUR SERVICES

| | REGULAR | STUDENT |
|--|---------|---------|
| FIB-SEM | | |
| FESEM Imaging | ₱7,500 | ₱6,000 |
| FESEM Imaging with EDX Point Analysis | ₱9,500 | ₱7,600 |
| FESEM Imaging with EDX Line Analysis | ₱11,500 | ₱9,200 |
| FESEM Imaging with EDX Mapping | ₱13,500 | ₱10,800 |
| FIB Sectioning (30µm W x 30µm H um cut) w/ FESEM Imaging | ₱14,000 | ₱11,200 |
| TEM Lamella Preparation | ₱19,000 | ₱15,200 |
| STEM Imaging | ₱12,000 | ₱9,600 |
| FIB Pattern Deposition with FESEM Imaging | ₱14,500 | ₱11,600 |
| AES | | |
| AES Point Analysis | ₱9,700 | ₱7,760 |
| AES Line Analysis | ₱11,900 | ₱9,520 |
| AES Mapping | ₱16,000 | ₱12,800 |
| AES Depth Profiling | ₱23,500 | ₱18,800 |
| AES Chemical State Analysis (add-on) | ₱1,500 | ₱1,200 |
| TOFSIMS | | |
| TOFSIMS Spectroscopy | ₱13,300 | ₱10,640 |
| TOFSIMS Mapping | ₱16,400 | ₱13,120 |
| TOFSIMS Depth Profiling | ₱24,000 | ₱19,200 |
| TOFSIMS 3D Mapping | ₱26,600 | ₱21,280 |
| FTIR | | |
| FTIR Spectroscopy | ₱5,000 | ₱4,000 |
| FTIR Spectroscopy (no ID) | ₱3,500 | ₱2,800 |
| FTIR Microspectroscopy | ₱6,500 | ₱5,200 |
| FTIR Microspectroscopy (no ID) | ₱5,000 | ₱4,000 |
| Thermal Analysis | | |
| Differential Scanning Calorimetry | ₱3,000 | ₱2,400 |
| Simultaneous Thermal Analysis | ₱3,000 | ₱2,400 |
| Thermomechanical Analysis | ₱3,200 | ₱2,560 |
| TG-IR | ₱8,300 | ₱6,640 |
| Sample Preparation | | |
| Optical Microscopy | ₱2,000 | ₱1,600 |
| Mechanical Preparation | ₱3,800 | ₱3,040 |
| Ion Milling | ₱4,500 | ₱3,600 |
| Chemical Decapsulation | ₱3,000 | ₱2,400 |
| Particle Size Analysis (add-on) | ₱1,500 | ₱1,200 |
| Sputter Coating | ₱2,000 | ₱1,600 |
| Biological Fixing | ₱2,500 | ₱2,000 |
| Laser Decapsulation | ₱4,200 | ₱3,300 |
| Laser Decapsulation with 2D X-Ray | ₱6,800 | ₱5,400 |
| Non-destructive Testing | | |
| 3D CT X-Ray Single Scan | ₱17,400 | ₱13,900 |
| 3D CT X-Ray Bulk Price add-on | ₱8,800 | ₱7,000 |
| 3D CT X-Ray Additional Scan add-on | ₱9,550 | ₱7,600 |
| 3D CT X-Ray Analysis add-on | ₱2,600 | ₱2,000 |
| 3D CT X-Ray Reference Comparison add-on | ₱2,750 | ₱2,200 |
| Hand-Held XRF Analysis | ₱2,200 | ₱1,800 |
| 2D X-Ray Single Scan/Qualification Scan | ₱5,800 | ₱4,600 |
| 2D X-Ray Bulk Scan with Analysis(Subsequent) | ₱4,800 | ₱3,800 |
| 2D X-Ray Scan Only(Consequent) | ₱3,200 | ₱2,600 |



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COUNCIL
LOGIES (DOST-PCIEERD)

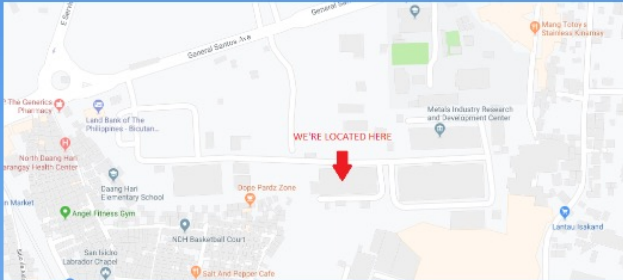


Advanced Manufacturing Center (AMCEN)



**MATERIALS
DEVELOPMENT**

Materials Development



Address: MIRDC Compound Gen.
Santos Ave. Bicutan 1631, Taguig,
Metro Manila, Philippines

Telephone: 8837-0431 to 38 Local: 801

Email: amcen@dost.gov.ph

Powered by [Froala Editor](#)

[Contact Us](#)

This is one of the component projects of the Advanced Manufacturing Center (AMCen). It aims to develop various materials from local sources for use on single and multi-material additive manufacturing (MM-AM). Specifically, the objectives are:

1. establishment of a facility for design, materials development and testing for additive manufacturing prototyping;
2. enhance capability on design, materials development from local sources and testing for additive manufacturing application in accordance with standards;
3. qualification, characterization and development of local raw materials for single and multi-materials for additive manufacturing application;
4. development, characterization, testing and prototyping using developed materials for multi-material additive manufacturing;
5. optimization of performance and material utilization in additive manufacturing.



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UNCIL
S (DOST-PCIEERD)



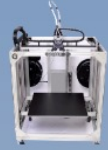
Technologies



Tabletop Blue Light 3D Sc...

The Solutionix C500 is a structured light 3D scanner optimized for scanning...

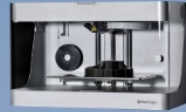
[See More](#)



FDM Printer Open Chamber ...

Fulfilling your large-format 3D printing needs, re:3D now offers Gigabot XL...

[See More](#)



3D Printer for Polymer Fi...

Print composite parts as strong as aluminum on our top-of-the-line desktop ...

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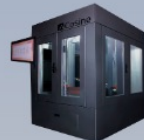
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Program Chairperson
Mechanical Engineering Department

ENGR. ERMIE M. BACARRA
Chief Science Research Specialist
DOST-PCIERD

FR. MARCELO V. MANIMTIM, CM
President
Adamson University

A grayscale photograph of a person's hands holding a large, dark, 3D printed object, possibly a mold or a part. The person is wearing a dark shirt. In the background, a laboratory setting is visible with a white countertop, a black stool, and some equipment. A large green circle is overlaid on the right side of the image, partially obscuring the background. The text "Additive Manufacturing Research Laboratory (AMReL)" is overlaid in white at the top right.

Additive Manufacturing Research
Laboratory (AMReL)

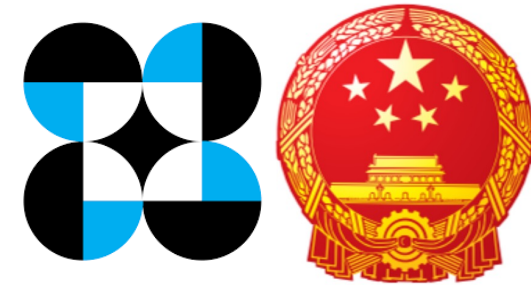
Bataan Peninsula State University (BPSU)

International Collaborations



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日本学術振興会



The Manila Economic and Cultural Office – Taipei Economic and Cultural Office
(MECO-TECO) Cooperation Scheme

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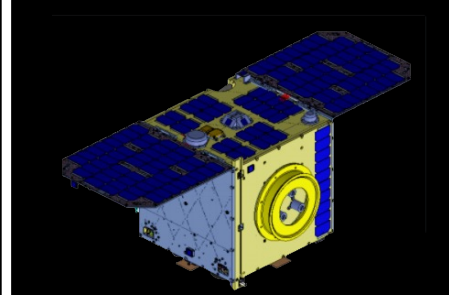
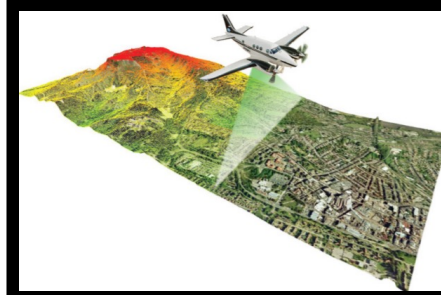
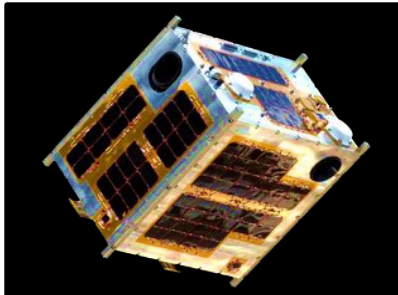
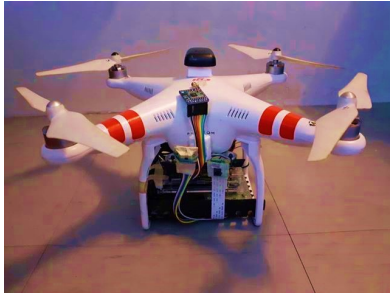
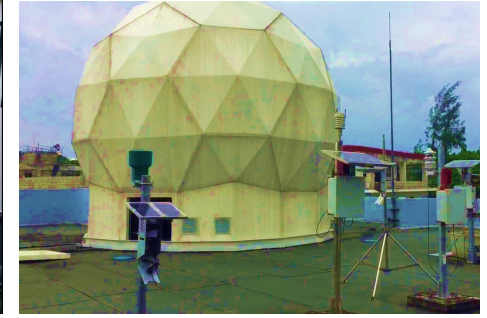
2023 CALL FOR PROPOSALS

Philippines-Korea Joint S&T Research Program



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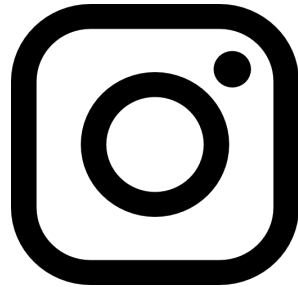
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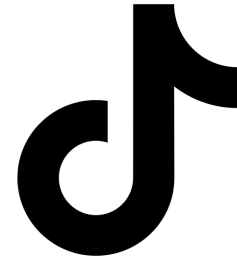
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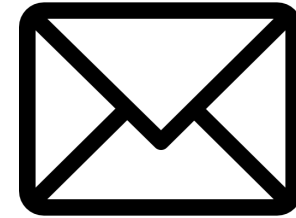
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