VII. ADVANCED MATERIALS AND NANOTECHNOLOGY SECTOR

A. Smart Materials

Call Rationale

Smart materials, also known as advanced materials or intelligent materials, are materials that can react to specific stimuli, or environmental changes. Such potential caught the attention of both researchers and industry alike, allowing them to integrate varied advanced technologies into compact, diverse functional packages, with the goal to develop advanced smart materials and to revolutionize the research field of smart materials (Bahl, et al., 2020). The development of smart materials is catalyzed by a technological revolution that will involve several emerging technologies such as materials science, neural network, artificial intelligence, nanotechnology, and biotechnology, among others. These smart materials have found applications in aerospace, mechanical and civil industries for the development and monitoring (Maurya, Rawat, & Jha, 2020).

Development of smart materials with coating applications is essential to various industries in the Philippines. Pharmaceutical and food Industries and even consumers are now keen on using paper-coated packaging to replace their plastic tetra packs. The development of renewable, bio-based, nano-coated mono- materials supports the long-term goals of pharmaceutical and food industries. However, based from literature, the current focus of development work in the manufacture of such packaging materials is still in extrusion technology.

While the application of nanoparticles in the synthesis of anti-corrosion coatings is one of the most important accomplishments of nanotechnology. It improves barrier properties, anodic and cathodic protection and enhances adhesive characteristics. Application as a corrosion inhibitor is also used in the synthesis of smart coatings.

Call Objective

The proposals to be submitted should be able to develop technologies in the following focal areas identified by industry stakeholders within two (2) years.

Call Scope

Priority areas identified are as follows:

- ***High temperature coatings for batteries, molten surfaces, and inhibitors for chemical and geothermal corrosion***

  Interested Partner Industry: Energy Development Corporation (EDC) and other industries requiring coatings for their products

- ***Coating for paper-/ cellulose-based packaging***

Interested Partner Industry: UNILEVER Philippines and other similar industries requiring sustainable packaging materials for their products

Specific Requirements: To ensure that the research output will be utilized by the target industry, a letter of commitment with counterpart (in cash or in kind) contribution must be secured. PCIEERD will fund one project per topic, not exceeding P15 Million budget for 2 years.

B. Materials Informatics

Materials Informatics is the discovery, characterization, and development of novel materials.

Call Scope

The proposals to be submitted should be aligned with the following priority topics, as follows:

- ***Materials platforms and tools***
  - Data-driven materials design of high-performance magnets
  - Alloy design by high-throughput DFT and machine surrogate models
  - Design of structural materials by data-driven approach in materials integration
  - Multiscale modeling for designing and understanding length scale effects in alloys
  - A library of 2D and 3D materials and screening process
  - High-performance computing infrastructure readiness for emerging computational materials science and informatics

- ***Materials informatics for materials development and processing***
  - Computer simulations of additive manufacturing toward site-specific microstructure engineering
  - Iterative combinational approach to materials development augmented with compositional graded Advanced materials fabrication with high-throughput screening
  - Tailoring advanced materials and components for lightweight and superior performance: design, process-microstructure-performance mapping

- ***Materials informatics for a low-carbon society***
  - Computational design and exploration of novel solid electrolytes for all-solid state batteries by DFT and machine learning
  - Machine learning for better analytics
  - Application of materials informatics to interface engineering of energy materials
  - Accelerated materials development with Machine Learning and High-performance computing and automated laboratories in the design of functional materials
  - Accelerated catalyst development platform

Specific Requirements: To ensure that the research output will be utilized by the target industry, a letter of interest together with a 3- to 5-year technology pathway must be submitted.

C. Nanosafety Program: Establishment of safety protocols for the use of nanomaterial safety (occupational and operational) Phase II

Call Rationale

Nanotechnologies pose new opportunities and challenges to both the industry and the regulatory bodies alike. Benefits of nanotechnologies include helping address societal and environmental challenges, (e.g. in providing renewable energy and clean water, and in improving health and longevity, as well as the environment). As the technology progresses, however, unlocking this potential will require responsible and co-coordinated approach to ensure that potential challenges will be addressed concurrently. The general approach towards safe handling and control of nanomaterials works the same as other types on materials. The UK's Control of Substances Hazardous to Health Regulation (COSHH) outlines a framework that can be applied also to the control of nanomaterials:

- identify the hazards and assess the risks;
- decide what precautions are needed;
- prevent or adequately control exposure;
- ensure that control measures are used and maintained;
- monitor the exposure;
- carry out appropriate health surveillance;
- prepare plans and procedures to deal with accidents, incidents and emergencies; and
- ensure employees are properly informed, trained and supervised.

These hazard levels are determined based on a risk assessment. This is dependent on a) hazardous properties of the nanomaterial and b) exposure level. From risk assessment, occupational safety measures can be derived following the priority list of the STOP principle: Substitution, Technical measures, Organizational measures and Personal protection measures. The appropriate occupational safety measures can be determined using evaluation criteria and the recommendations should be adapted to the respective national legislation of the respective member state. The decision criteria can support the risk assessment of activities with nanomaterials and lead to an appropriate safety strategy. The occupational safety measures are influenced by the quantity, the release potential, as well as the exposure level of the respective nanomaterial. A wide range of guidelines published from different institutions can additionally provide support in deriving the appropriate occupational safety measures, either specifically to handling nanomaterials or more generally to handling chemicals of the respective hazard groups and can additionally provide support in deriving the appropriate occupational safety measures.

Call Objective

The call aims to support specific R&D needs of the industry in terms of occupational and operational safety in the use of nanomaterials and the eventual adoption of risk assessment protocols by the industry and local regulatory agency.

Call Scope

To ensure that the research output will be utilized by the target industry or local regulatory agency, a letter of commitment must be secured.

D. Materials for Energy

Call Rationale

In the Philippines and in its neighboring countries, diverse power generation sources are being utilized. However, the country relies mostly on coal, followed by natural gas, oil and renewable energy (e.g. geothermal and hydrothermal). Local companies working on geothermal energy, however, may encounter concerns related to operational issues such as resource management, scaling control, diagnostics, power generation, wellbore intervention and high value product.

The reliance on fossil fuels is one of the most challenging problems that need to be dealt with vigorously in recent times. Since it is not sustainable and its continuous use leads to serious environmental issues, such as air pollution and global warming- consequently affecting economic security and development. An alternative to fossil fuel is highly possible which will be more environmentally friendly, sustainable and efficient as well. Among all the different technologies associated with renewable energy, fuel cell technologies represent one of the most promising technological advancements to curb the situation.

Call Objectives

The study should be able to produce a market-ready material that will result in a spinoff company or IP licensure. Topic should fall under any of the following:

- Fuel cells
- Single stack, polymer exchange membrane
- Deployment for energy generation and storage
- Supercapacitors:
- Non-Platinum alternatives, pseudo-capacitors, EDCL
- Development of solid-state supercapacitors and high-capacity supercapacitors out of better materials (conductive polymers, nanometal-oxides, lithium-air)
- Development of composite supercapacitors from conductive polymer and nano metal-oxide composites

The proposed priority action could be classified as follows:

- R&D Focused: The design and development studies would utilize and harness locally available raw materials as components of fuel cells
- Capacity or Institution Building: Researchers and industry partners would be trained for stack development and testing, fuel cell development for various applications, and robust research infrastructure (possibly under HRIDD).

Call Scope

Specific Requirements: To ensure that the research output will be utilized by the target industry, a letter of interest together with a 3- to 5-year technology pathway must be submitted.