科技部「臺美奈米材料基礎科學研發共同合作研究計畫」構想書徵求公告

(MOST-AFOSR Taiwan Nanoscience Basic Research Topological and Nanostructured Materials Synthesis and Discovery)

一、計畫目標

臺灣與美國空軍之國際合作計畫(MOST-AFOSR Taiwan Nanoscience Basic Research Topological and Nanostructured Materials Synthesis and Discovery)，係為臺灣與美國研究人員提供交流與合作的平台，藉此能夠了解國際研究方向，及激發奈米科學最新技術，臺美雙方於 107 年以同步公開徵求與各自補助計畫的方式開始進行合作。現在公開徵求 110 年度新的三年期雙邊合作計畫。

本徵求公告之訂定日期時間係以臺灣時間為準。

二、申請條件

(一) 計畫主持人與共同主持人之資格，須符合「科技部補助專題研究計畫作業要點」相關辦法之規定。申請機構須為本部專題研究計畫之受補助機關。本計畫歸屬「雙邊協議專案型國際合作研究計畫」件數，不列入本部研究計畫件數的額度計算，惟以 2 件為限。

(二) 合作對象：**需包含 1 個(含)以上的美方研究人員**。該美方研究人員之服務機構，必須為美國學術研究單位或美國國防部(DoD)之受補助實驗室。如對美方研究人員資格有疑問，請與本案美方負責人員聯絡。美國空軍聯絡人：AFOSR POC: Dr. Jeremy Knopp, Email: jeremy.knopp@us.af.mil

三、徵求內容

The scientific focus will be on Topological and Nanostructured Materials Synthesis and Discovery We seek proposals advancing the science in one or more of the following four concentration areas:

1) Topological and Qubit Materials
2) Novel Multifunctional Materials
3) Biocompatible Nanomaterials
4) Machine Learning Guided Materials Research

These concentration areas have potential applications in several possible systems for potential future transition.

Examples to consider in each of the concentration areas are as follows:

1. Topological and Qubit Materials:

Electronic topological states in materials are protected from some types of perturbation due to novel ordering, termed "topological," of their electron wave-functions. Enhanced coherence and the resulting robustness to perturbation makes these electronic states potentially useful for computation, communication, and sensing. Alternatively, qubit materials exploiting defects in solids have shown tremendous promise for low-noise sensors, unbreakable cryptography, and next-generation computing. In order to realize this promise, development of the fundamental and supporting technologies required to enable real-world applications is essential. The following are focus areas of interest:

a) Theoretical approaches to topological states: New approaches are sought to predict new topological states and materials which host such states, and to describe known topological states. Because topological properties vanish at high temperatures in most topological materials, prediction and realization of high-temperature topological states in quantum materials are desirable.

b) Synthesis, characterization and manipulation of materials with topological states: Fundamental understanding is sought regarding the relationships between properties of the topological state and growth parameters, as well as the relationships of the topological state to material point and extended defects. Discovery is also desirable regarding coupling and interactions between different topological states, as well as between topological states and other matter (e.g., magnetic materials, superconductors, etc.).

c) Quantum sensing: New approaches are sought that can achieve higher sensitivity, the measurement of distinct quantities, or the characterization of higher order effects. Proposed concepts could include, but, are not limited to, the development of novel qubits, distributed sensing, or new sensing techniques.

d) Improved coherence and entanglement: Quantum entanglement is fundamental to both networking and computation; however, modern qubits are limited in the number of nodes that can be entangled and operations that can be completed prior to decoherence. Concepts should seek to achieve long-lived coherence and entanglement between states through the development of novel state preparation techniques, faster and more robust entanglement approaches, novel qubits, qubit material refinement, phonon control, or alternative approaches.

2. Novel Multifunctional Materials:

High-performance, multifunctional materials enable devices and components for intelligence, surveillance, and reconnaissance systems as well as modern information technology. Therefore, scientific advances in multifunctional materials are sought in the following focus areas:

a) Novel electronic materials: The goal is to provide new functionalities or extend the performance and power handling in power, RF, and digital electronics applications.

b) High-performance optoelectronics: New materials and concepts in optoelectronics are needed to advance applications in communication, optical sensing, and optical processing. A particular focus is on material hetero-integration for integrated photonics; i.e., on Si or other suitable semiconductor substrates.

c) Novel materials beyond electronics/optoelectronics: There are emerging materials with operating mechanisms beyond using charged carriers and photons. For example, magnetism, spin wave, ferroelectricity, piezoelectricity, sound wave, plasmonics, etc., are all unconventional ways to carry and/or process information. Exploration of emerging materials using one or a combination of these mechanisms is desirable.

3. Novel Biomaterials and Interfaces

The focus is the design, synthesis, and characterization of bio-compatible/derived/ inspired materials with novel properties (e.g., surface chemistries, multifunction structural mechanics) capable of interfacing with natural or synthetic systems. Synthetic biology is poised to re-invigorate research areas such as pervasive, networked biosentinels for remote environmental sensing, but may also revolutionize how/what materials can be produced with targeted properties across length scales encompassing molecular building blocks to bulk materials. Characterization of these multifunctional structures in model systems (for instance, organ-on-a-chip) is necessary to confirm functionality in complex environments. Approaches to monitor the sensing event by hands-off means (e.g., RF, magnetic, etc.) will be critical to understanding potential transitions.

a) Hybrid, interfaced, organic and inorganic systems for environmental sensing: Materials of interest include integrated biological polymers with semiconductor/electrically-active properties. Additionally, platforms are sought that integrate novel recognition elements like natural or artificially generated receptor-based systems for biomarker monitoring, capable of high-throughput, label-free characterization via multiplexed arrays that do not require intricate specificity (e.g., pattern-based signaling and matrix-based sensing outputs).

b) Novel Materials: Materials are desired with new functionality/characteristics that arise from unique biology that current/traditional materials science and manufacturing research cannot address. Also of interest is the design/manufacture of sustainable, alternative (replacement) biomaterials.

c) Bio-inspired material designs and assembly methods: Approaches are needed for making new materials outside the bounds of nature, e.g., engineering ribosomes to use new monomers, or going beyond ribosomes altogether. Other interest areas include sequence-encoded block co-polymers to include more orthogonal chemistry and high performance materials based on synthetic proteins.

4. Machine Learning Guided Materials Research

Matured machine learning tools have been useful in data automation, smart communication, design innovation, and autonomous decision making. Machine learning approaches are now being adapted for materials discovery and efficient materials design of complex constituents and functionality. Accuracy and adaptability of machine learning related to nanomaterials research is highly desired. Suggested focus areas for this topic follow:

a) Machine learning for quantum materials: Meso-scale machine learning methodology is needed for training rules on defect influence on quantum response in nanomaterials.

b) Design rules on 2-D materials heterostructure assembly: Fundamental understanding is needed with regards to interfacial effects of heterostructure assembly (spatial or thickness stacking) on electron, photon, phonon transport behavior.

c) Machine learning for sensing materials: Physics-based machine learning rules are desired for defect design in 2-D materials for sensor performance (optical, thermal, electronic, or magnetic).

d) Machine learning for hybrid materials: 2-D materials hybridization design rules are sought for targeted properties.

四、申請流程與注意事項

1. 申請流程：本計畫申請區分「構想書(Pre-proposal)」及「完整計畫書(Full-proposal)」兩階段，由臺美雙方共同審查。**臺美雙方之申請人，必須分別向其補助機構依規定提出申請書。**
2. 構想書格式：如附件，且每位申請人(/計畫主持人)**以申請 1 件為限**。
3. 計畫執行期限：民國 110 年 8 月 1 日至 113 年 7 月 31 日，共 3 年。
4. 經費編列注意事項
   (1) 補助金額：上限以新臺幣 300 萬元/年為原則。
   (2) 注意事項：計畫主持人配合臺方與美方之相關規劃，進行年度或期末成果簡報致使產生業務費、國外差旅費等相關支出，由該計畫經費項下勻支，不得另案再向本部申請。
5. 構想書申請期限及送達方式：請循本部「專題研究計畫／(構想書計畫類別)臺美奈米材料基礎科學研發共同合作研究計畫構想書」線上申請方式作業，申請截止日期為 **109 年 12 月 21 日(含當日)**。
   申請人於系統繳交送出後，顯示「計畫狀態：繳交送出(科技部)」。
   本階段我方申請案**不須**經申請人任職機構於系統中彙整後送出。
6. 構想書審查方式：確定臺美雙方之申請人皆符合申請資格後，如有必要，申請人需至本部進行簡報並接受詢答，未進行簡報者，其申請案不予推薦。本計畫經費係專款專用，無申覆機制。
7. 審查重點：
   - 研究內容必須具有創新性，著重於基礎科學原創性研究。
   - 雙邊合作的必要性。
   - 具發展潛力及未來性。
8. 構想書審查結果通知：構想書審查獲推薦者，將由本部自然司暫訂於 110 年 2 月 5 日(星期五)前正式行文通知申請機構與申請人於期限內(暫訂 110 年 3 月 31 日前)提送完整計畫書(Full-proposal)，由申請機構造具名冊備函送達本部。

六、成果報告繳交、審查及評鑑

計畫主持人除依本部規範繳交研究成果等報告外，應於全程期末配合本部辦理成果審查等計畫評鑑作業。計畫主持人亦須配合臺方與美方之相關規劃，進行年度或期末成果簡報。

七、聯絡資訊

科技部自然司：王心頎小姐，Tel：02-2737-7522。
徐文章研究員，Tel：02-2737-7522。
美國空軍：AFOSR POC: Dr. Jeremy Knopp, Email: jeremy.knopp@us.af.mil