Call for Proposals
AFOSR-Taiwan NSTC Frontiers in Materials and Nanostructures: AI-Driven Discovery, Quantum Geometry, and Energy-Efficient Information Technologies
2027-2030

The US Air Force Office of Scientific Research (AFOSR) and Taiwan's National Science and Technology Council (NSTC) announce the solicitation for a three-year program entitled "Frontiers in Materials and Nanostructures: AI-Driven Discovery, Quantum Geometry, and Energy-Efficient Information Technologies."

History:
The US Air Force-Taiwan Nanoscience Program is one of the Air Force Office of Scientific Research's (AFOSR) International Research Initiatives. This international program is focused on shaping the direction and advancing the state-of-the-art in nanoscience research. Starting in 2002, grants were provided to Taiwan investigators to focus on basic research in specific nanoscience areas of interest as described by program managers at AFOSR or at the Air Force Research Lab (AFRL). In 2011 the program evolved to become a collaborative effort to pair US and Taiwan investigators to conduct basic science research on topics of common interest. In order to continue to provide opportunities for scientists to collaborate in emerging technology areas and to leverage their intellectual resources, AFOSR and NSTC are offering a new program dedicated to frontiers in materials and nanostructures in a variety of topic areas.

Eligibility:
This is an open call with open competition; therefore, all applications are welcome. Initial applications (pre-proposals) must have two investigators - one from a US institution or DoD Lab, and one from a Taiwan institution. Teams consisting of a US investigator and his/her counterpart from Taiwan are invited to submit a joint pre-proposal (white paper) indicating what their collaboration could accomplish with three years of funding. Each US-Taiwan pair is to submit only one pre-proposal. The same pre-proposal is to be submitted to both AFOSR and NSTC.

Scientific Topics:
Expected outcomes are that basic scientific research funded under this program will have results published in the open literature, will complement existing basic and applied research efforts at AFRL and NSTC, and will foster greater scientific collaborations between the US and Taiwan at the investigator level. The scientific focus will be on frontiers in materials and nanostructures that can advance science in the following concentration areas:

1. AI-driven materials discovery: We seek fundamental studies that integrate artificial intelligence, physics-based modeling, and experimental feedback to accelerate the discovery, synthesis, and understanding of solid-state materials, nanostructures, interfaces, molecules, and hybrid systems. Rather than purely data-driven screening or incremental database mining, this call emphasizes physically interpretable, uncertainty-aware, and experimentally validated approaches that reveal structure-property-function relationships across unexplored chemical, structural, and processing spaces. These efforts should enable predictive design of materials with targeted functionalities. Proposals are expected to align with one or more of the following core research tracks:

* **Physics-informed AI and quantum-level modeling:** Proposals may integrate machine learning with ab initio electronic-structure methods, quantum chemistry, molecular dynamics, many-body theory, or multiscale simulations to improve the accuracy, transferability, and efficiency of materials prediction. Emphasis should be placed on physically constrained and interpretable models that can predict key material properties while revealing the underlying structure–property relationships.

* **Predictive discovery, inverse design, and synthesis optimization:** Proposals may develop AI-guided approaches to identify stable or metastable materials, molecules, nanostructures, defects, interfaces, and heterostructures with targeted properties. Particular emphasis should be placed on uncertainty quantification, synthesis-aware design rules, closed-loop optimization, and experimentally testable predictions.

* **AI-enabled multiscale modeling of complex materials:** Proposals may leverage AI to bridge atomistic, mesoscale, and continuum descriptions of heterogeneous, disordered, interfacial, or nonequilibrium systems, including complex solids, molecular assemblies, low-dimensional heterostructures, multifunctional interfaces, and nanostructures whose properties emerge across multiple length and time scales.

2. Materials and nanostructures for energy-efficient electronic, photonic, and quantum information technologies: High energy demand driven by the rapid development of artificial intelligence represents a major challenge, making sustainable computing infrastructure highly desirable. We seek innovative materials and nanostructures that enable high-performance, low-power operation across computation, memory, data storage, optical interconnects, photonic or optoelectronic information processing, and emerging quantum information functionalities. Rather than system-level optimizations or conventional CMOS iterations, this call targets the synthesis, deterministic manipulation, and microscopic characterization of novel material phases, low-dimensional heterostructures, functional interfaces, and nanoscale photonic structures engineered to approach fundamental limits of energy-efficient information processing. Emphasis should be placed on material mechanisms, interfacial phenomena, nanoscale control, and experimentally measurable physical observables relevant to energy-efficient information processing.

3. Quantum geometry in solids:

Quantum geometry describes how electronic wavefunctions evolve in momentum space and governs emergent properties of solids, including topological and anomalous transport, nonlinear optical responses, and flat-band superconductivity. We seek scientific breakthrough to advance our understanding of quantum-geometric responses in materials. These efforts may guide the prediction and realization of new materials with enhanced emergent properties, potentially including robust high-temperature topological states. Proposals are expected to align with one or more of the following core research tracks:

* **Advanced Experimental Methodologies to Resolve Quantum Geometry**: We seek new experimental methodologies to resolve quantum geometry in crystalline solids.

Applicants are encouraged to extend these approaches to broad classes of quantum materials, such as topological materials, flat-band systems, moiré heterostructures, and superconductors. Methods that quantitatively isolate intrinsic Berry curvature and quantum metric contributions from conventional or extrinsic background responses, and benchmark experimental results against realistic first-principles or model calculations are desirable.

* **Novel Theoretical Frameworks Beyond DFT**: We seek new theoretical frameworks in which quantum geometry serves as a central descriptor of solids, complementing conventional band dispersion, symmetry, and Fermi-surface-based descriptions. Such frameworks should address realistic multiband, strongly correlated, disordered, and many-body systems, including, where relevant, interband mixing, electronic interactions, finite quasiparticle lifetimes, and non-translational configurations through Green's-function, diagrammatic, or kinetic approaches. They should clarify how quantum geometry governs nonlinear optical responses, transport, superconductivity, and collective phases, while providing experimentally testable criteria for separating intrinsic quantum-geometric effects from extrinsic contributions. The ultimate goal is to establish predictive design principles for quantum materials with enhanced novel functionalities.

Further information about areas of interest can be found in the AFOSR Broad Agency Announcement (FA9550-26-S-0001) at https://www.grants.gov/search-results-detail/362681.

Funding Level:
AFOSR will fund the selected US investigators. Available funding for the selected set of US projects is $1,200,000 per year for three years. The examples listed are based on 8 funded projects; the final amounts to be allocated will be determined by the final number of team awardees. NSTC will similarly fund the selected Taiwan investigators.
Year 1 (2027-2028) – up to $150,000 for US PIs
Year 2 (2028-2029) – up to $150,000 for US PIs
Year 3 (2029-2030) – up to $150,000 for US PIs

Application Process, Timeline, and Submission Information
Pre-proposal (white paper) Phase: Each team consisting of a US PI and a Taiwan PI are to submit a joint pre-proposal (white paper). The technical narrative should be no more than three (3) pages and should include basic content such as problem statement, hypothesis, method of investigation, uniqueness of approach, and potential payoff. The following two items should be included as appendices (not counted against page count): biographic information on Taiwan and US research team members and simple budget.

Pre-proposals should be submitted via email to AFOSR Points of Contact (POC):
Lt Col Alexander Kamrud, alexander.kamrud.1@us.af.mil
and to the NSTC online system by **2 October 2026**.
Applicants in Taiwan can direct the questions to the NSTC POCs:
Dr. Tien-Ming Chuang, chuangtm@gate.sinica.edu.tw
Dr. Ian Liau, ianliau@nycu.edu.tw

All received pre-proposals will be reviewed independently by AFOSR and NSTC representatives. Evaluation criteria will include the scientific merit of the proposal, the unique synergy enabled by the US-Taiwan team, and the potential for transition to systems with AFRL and NSTC interest. Up to twenty (20) investigator pairs will be invited to submit full proposals. The selection of the research teams recommended to submit full proposals will be announced by **15 January 2027**.

Full Proposal Phase: Based on the technical content of the selected pre-proposals (white papers), full proposals will be developed independently by the US and Taiwan PI and submitted to their respective agency, AFOSR or NSTC, following the procedures of that agency. The full proposal should include a technical narrative of no more than eight (8) pages and expand on the ideas set forth in the pre-proposal to include a detailed plan of study. Though the full proposals will be submitted independently, each one should explain how collaboration with the counterpart from Taiwan or the US would create synergy and increase the potential for scientific breakthroughs beyond what could be accomplished separately. Investigator CVs and a detailed budget should be appended (not counted against page count). Full proposals will be due by **19 February 2027**.

US PIs: If your pre-proposal is selected for the full proposal phase, you will be provided with a template package and instructions at that time. Full proposals are to be submitted through the funding opportunity FA9550-26-S-0001 at grants.gov (https://www.grants.gov/search-results-detail/362681), Asian Office of Aerospace Research and Development (AOARD), PKG00293126. The evaluation of full proposals will be made independently by AFOSR and NSTC representatives. The announcement for the awards will be made by **30 April 2027**. Applicants funded by the AFOSR are subject to the terms and conditions described in the current AFOSR Broad Agency Announcement. Evaluation criteria and review are subject to the terms and conditions described in the current AFOSR Broad Agency Announcement. The approximate starting time for the selected projects is **October 2027**, and the period of performance will continue for three years until approximately **October 2030** (actual dates will depend on the Grant award process).

Funded investigators are expected to attend joint annual program reviews and present research progress. Though subject to change, the intent is to alternate program review locations between Taiwan and the US. Annual and final reporting requirements for US PIs are in accordance with AFOSR Grant policy.