Seed Projects
Exploratory Research

Seed funding advances world-leading exploratory research that is novel, exciting, and interdisciplinary with significant opportunities for growth if successful.

Frontiers of Phonon Transport Across Interfaces: Development of Mode-Selective Phonon Pump-Probe Spectroscopy

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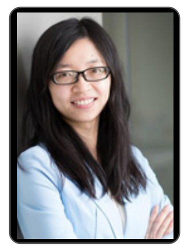

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The goal of this seed is to transform interface engineering efforts by developing a first-of-its-kind mode-selective phonon pump-probe technique for resolving heat transport across interfaces into contributions from specific modes. Dissipating the substantial head loads generated in modern electronic devices is a critical challenge facing future technologies, such as interconnects for next-generation computing platforms. Understanding and engineering the thermal behavior at the interface is key to solving this challenge. Our team combines the necessary expertise in first-principles theory of lattice (phonon) dynamics and complex interfaces thermal transport measurements and modeling ultrafast laser technology and THz pump-probe spectroscopy to open this new avenue for the study and optimization of thermal behavior in nanoscale devices.

Chiral Spintronics

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Spintronics is an area of science and technology that exploits electron spin for technology such as logic circuits, with potential application in quantum information devices. Recently, chiral organic molecules have been shown to discriminate spins at room temperatures, as beautifully demonstrated with DNA ten years ago. In this phenomenon called Chirality Induced Spin Selectivity (CISS), charge transfer through certain chiral molecules results in a distinct chirality-dependent electronic spin polarization. The discovery of CISS opens up the possibility to manipulate spin orientation at room temperatures, without the use of external magnetic fields or exchange interaction with magnetic atoms, thus preserving time-reversal symmetry and enabling the expansion into new spintronic devices for quantum information science. This seed project will study a chiral mesophase material for CISS, leveraging a unique nanomaterial developed at Cornell.

Combining Reasoning and Learning for Accelerating Discovery of Refractory High Energy Alloys

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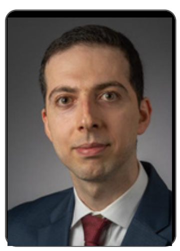

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There is a high demand for metallic materials that can operate at temperatures much higher than what can be offered by the current Ni-based superalloys. High Entropy Alloys (HEAs) and especially those based on refractory elements, have shown promising properties to extend the range of operating temperatures of structural materials. In the HEA design concept, the base alloy commonly has four or more elements as opposed to a single principal element in conventional alloys. For an efficient search within this high dimensional design space, we develop DREAM (Deep learning and Reasoning to Enable Accelerated discovery of Materials) framework using advanced AI knowledge and data driven techniques. We plan to use novel bulk combinatorial synthesis technique enabled by additive manufacturing. When combined with emerging data-intensive characterization methods such as site specific, high throughput nanoindentation, they open a path toward augmenting the knowledge-based data science approaches to uncover yet unknown composition-microstructure-property relationships in these materials. We will use advanced microscopy techniques across length scales to understand the underlying physics governing the enhanced properties of discovered materials.