



From Fundamentals to Function: The Role of Lone Pair Electrons in Advancing Halide Perovskite Technologies

Prof. Mercuri G. Kanatzidis

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Materials Science and Engineering
Northwestern University, USA**

This presentation focuses into the exceptional capabilities of lead and tin halide perovskites, spotlighting their significant promise in fields such as photovoltaics and radiation detection. Central to our discussion is the pivotal role played by the lone pair of electrons on Pb^{2+} and Sn^{2+} ions, a factor that profoundly shapes the materials' physical characteristics. We will place a particular emphasis on the revolutionary contributions of both three-dimensional (3D) and two-dimensional (2D) perovskite structures to the future of optoelectronic devices. Additionally, the critical importance of synthesis methods in modifying these properties will be examined, showcasing how mastery over material creation can enhance device performance. By discussing the essential chemistry underlying these materials, the talk aims to forge a link between theoretical understanding and tangible technological advancements, as a way for significant progress in the field.

Mercuri Kanatzidis is a distinguished scientist and educator with a prolific career spanning over three decades. He is a Charles E. and Emma H. Morrison Chair Professor of Chemistry and Professor of Materials Science and Engineering at Northwestern University, where he has been leading cutting-edge research and mentoring future scientists since 2006. Prior to joining Northwestern, Kanatzidis was a Distinguished Professor at Michigan State University, where he made significant contributions to the field of inorganic chemistry. Throughout his career, Kanatzidis has made groundbreaking discoveries and developed materials that have been instrumental in advancing alternative energy technologies. His work has focused on improving thermoelectric materials for waste heat recovery, which can help to reduce energy waste and lower carbon emissions. Kanatzidis and his team also developed the first solid-state solar cell device using a film of tin iodide perovskite in a solid-state dye-sensitized cell, achieving an efficiency of around 10%. This discovery has paved the way for the development of more efficient and stable solar cells. Kanatzidis is a highly cited researcher in chemistry, with over 1,550 published manuscripts and more than 45 patents to his name. He has also mentored over 100 Ph.D. students and nearly 120 postdoctoral fellows, helping to shape the next generation of scientists and engineers. Born in Greece, Kanatzidis received his B.S. degree from Aristotle University and his Ph.D. from the University of Iowa. He was elected to the American Academy of Arts and Sciences and U.S. National Academy of Sciences.

- **Date : 2024/06/05 13:00-14:00**
- **Location : 302동 809호**
- **Contact : 정인 교수(880-7408) TA: 송형준(880-1530)**



Solution-Processed Inorganic Thermoelectric Materials: New avenues for material control

Prof. Maria Ibanez

Institute of Science and Technology of Austria

Over the past few years, there has been a significant surge in interest surrounding solution-based techniques due to their cost-effectiveness and scalability in the production of high-performance thermoelectric materials. This approach involves the synthesis of particles in a solution, followed by their purification and thermal processing to yield the desired dense polycrystalline material. Unlike traditional methods, solution-based syntheses offer the ability to manipulate particle characteristics, including size, shape, crystal structure, composition, and surface chemistry, to an unprecedented degree. This precise control over powder properties creates unique opportunities for crafting thermoelectric materials with meticulously controlled microstructural attributes. In this presentation, we will highlight the opportunities and challenges that this synthetic strategy can bring, in particular we will focus on metal chalcogenides.

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Hierarchical Composites through Nanoscale Engineering

Prof. Pierre F. P. Poudeu

**Laboratory for Emerging Energy and Electronic Materials,
Department of Materials Science and Engineering,
University of Michigan, Ann Arbor, USA**

Materials design by entropy stabilization has proven an efficient approach to engineer new alloys with unique properties. Entropy stabilization exploits the large configurational entropy of multi-principal-element alloys to overcome the mixing-enthalpy barrier and stabilize solid solutions of otherwise immiscible materials. Despite the recent advances in entropy-stabilized materials, prior work has focused on metals and insulating ceramics. Entropy-stabilized alloys with semiconducting character, i.e. exhibiting a tunable band gap and controllable ambipolar doping, had not been demonstrated until the report by Poudeu and Kioupakis of the multi-cationic and -anionic (Ge,Sn,Pb)(S,Se,Te) entropy-stabilized chalcogenide alloys called high-entropy chalcogenides (HEC). The configurational entropy from the disorder of both the anion and the cation sublattices reaches a record value of $\sim 2.2 R \text{ mol}^{-1}$ for the equimolar composition and stabilizes the single-phase solid solution. In this talk I will discuss the theoretical prediction and the experimental validation of HEC, their thermodynamic as well as kinetic stability and metastability at various temperatures. I will also discuss the effect of individual element on the stabilization of HEC solid solutions.

P. Ferdinand Poudeu is a Professor of Materials Science and Engineering at the University of Michigan. He earned a Ph.D. in Inorganic Solid-State Chemistry (2004) from the Technical University of Dresden in Germany and conducted postdoctoral study (2004 – 2007) at Michigan State University and at Northwestern University. Dr. Poudeu started his independent career as an Assistant Professor of Chemistry and Materials Science at the University of New Orleans (UNO) from 2007 to 2011. In 2011, Dr. Poudeu moved to the Department of Materials Science and Engineering at the University of Michigan and established the "Laboratory for Emerging Energy and Electronic Materials (LE3M)". Dr. Poudeu was promoted to the rank of Associate Professor with tenure in 2015 and to full Professor in 2020. His laboratory conducts advanced research on various topics including (1) Bulk Nanostructured Thermoelectric Materials; (2) Novel Low-dimensional Spintronic Materials; (3) Hierarchical Hybrid Multifunctional Materials; (4) Strongly Coupled Optoelectronic Heterostructures. Dr. Poudeu's scientific accomplishments are well documented in over 140 published (google scholar h-index: 32) peer-reviewed research articles. Dr. Poudeu has graduated 11 PhDs, mentored 16 Master's students, 6 postdoctoral research associates, over 50 undergraduate students; 8 high school students; and 2 high school teachers. Dr. Poudeu served as the chair of the University of Michigan Master's program in Materials Science and Engineering from 2015 to 2023. Dr. Poudeu's achievements have been recognized by several honors and awards, including, a Career Award from NSF-DMR (2010), a special creativity extension award from NSF-DMR (2019), an Early Research Professorship from UNO (2010), an Outstanding Accomplishment Faculty Award from UM-MSE (2019)

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