Metal Halide Perovskite Nanostructures for Optoelectronic Applications and Fundamental Studies

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Résumé/Abstract: The remarkable solar performance of lead halide perovskites can be attributed to their excellent physical properties that present many mysteries, challenges, as well as opportunities. Better control over the crystal growth of these fascinating materials and better understanding of their complex solid state chemistry would further enhance their applications. Here I will first report new insights on the crystal growth of perovskite materials and the solution growth of single crystal nanowires and nanoplates of methylammonium (MA), formamidinium (FA), and all-inorganic cesium (Cs) lead halides perovskites ($APbX_3$) *via* a dissolution-recrystallization pathway. We demonstrated high performance room temperature lasing with broad tunability of emission with these single-crystal perovskite nanowires. We also developed the epitaxial growth of perovskite materials and 2D heterostructures of Ruddlesden–Popper (RP) layered lead iodide perovskites with controlled phases, which can be used as the model systems to study the carrier transfer mechanisms between different RP phases and as the building blocks for optoelectronic devices. The excellent properties of these single-crystal perovskite nanostructures of diverse families of perovskite materials with different cations, anions, and dimensionality make them ideal for fundamental physical studies of carrier transport and decay mechanisms, and for enabling high performance lasers, LEDs, and other optoelectronic applications.

Biography

Prof. Song Jin received his B.S. in Chemistry from Peking University in 1997, Ph.D. in 2002 from Cornell University under the direction of Prof. Francis J. DiSalvo and carried out his postdoctoral research under the direction of Prof. Charles M. Lieber at Harvard University. Dr. Jin is interested in the chemistry, physics and technological applications of nanoscale and solid-state materials. Dr. Jin developed innovative synthesis of a variety of nanomaterials including metal chalcogenides, oxides, silicides, and halide perovskites, and discovered and developed the screw dislocation-driven growth of nanomaterials. Building on the fundamental understanding of novel physical properties, Jin advances the exploitation of (nano)materials for electrocatalysis, solar energy conversion, energy storage, optoelectronics, nanospintronics, and biotechnology. A unifying theme of Jin's energy research is the focus on earth-abundant materials. Dr. Jin has authored or co-authored over 200 publications and 7 patents. He has been recognized with a NSF CAREER Award, a Research Corporation Cottrell Scholar Award and as one of world's top 35 innovators under the age of 35 (TR35 Award) by the MIT Technology Review Magazine, the ACS ExxonMobil Solid State Chemistry Fellowship, and the Alfred P. Sloan Research Fellowship, U. of Wisconsin-Madison Vilas Associate Award and H. I. Romnes Faculty Fellowship, and the ACS Inorganic Nanoscience Award. He also serves as a Senior Editor for *ACS Energy Letters*.