Atomic Electron Tomography: 3D Structures without Crystals

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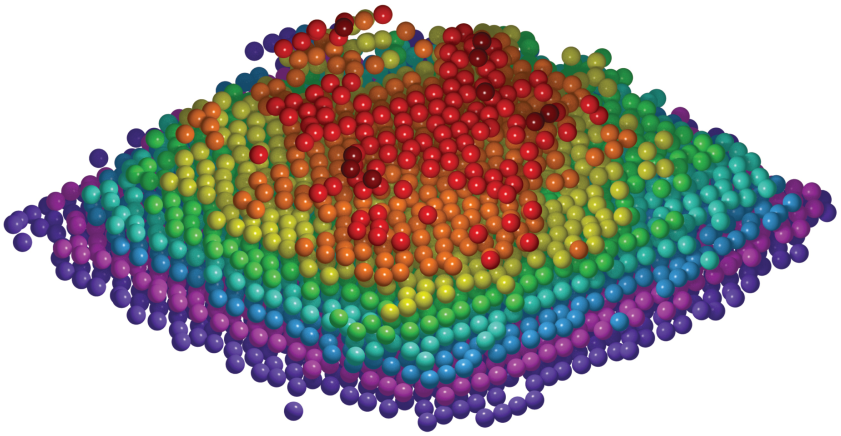
The discovery and analysis of x-ray diffraction from crystals by Max von Laue, William Henry Bragg and William Lawrence Bragg in 1912 marked the birth of crystallography. Over the last century, crystallography has been revolutionized many fields of science and the United Nations General Assembly proclaimed 2014 as the International Year of Crystallography. However, perfect crystals are rare in nature and much of our modern science and technology relies on crystal defects and non-crystalline systems. These include heterogeneous catalysis (reactions on nanoparticle surfaces), renewable energy (amorphous silicon), information processing (defects and dopants in semiconductors), energy storage (solid electrolyte glasses and oxides) and metal hardening (dislocations and grain boundaries). In these applications it is not just the average structure, but also the defects and crystalline imperfections that need to be engineered to obtain the desired properties.



Atomic electron tomography allows the determination of the 3D positions of individual atoms in materials to a precision of 19 trillionths of a meter, which is several times smaller than a hydrogen atom.

In this USIAS seminar, Prof. Jianwei (John) Miao from UCLA will present a groundbreaking methodology, termed atomic electron tomography, to determine the 3D atomic structure of crystal defects such as grain boundaries, stacking faults, dislocations and point defects, and to precisely localize the 3D coordinates of individual atoms in materials without assuming crystallinity. In collaboration with Prof. Ovidiu Ersen from Strasbourg University, this USIAS project aims to identify all the 3D positions of individual atoms in single nanoparticles and then monitor the 3D motion of these atoms under realistic environments. The ability to determine the 3D structure of crystal defects and non-crystalline systems at atomic resolution is expected to transform our understanding of structure-property relationships in materials science, chemistry, physics, nanoscience and nanotechnology in the 21th century.

References:

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