東京大学グローバルCOEプログラム　機械システム・イノベーション国際拠点

東京大学 THE UNIVERSITY OF TOKYO

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Atomic resolution transmission electron microscopy

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要旨

Atomic resolution imaging is possible in scanning transmission electron microscopy (STEM) using a number of different signals. Electron energy-loss spectroscopy (EELS) based on core-loss signals yields chemical maps that can be understood using a rigorous quantum mechanical formulation. It is also now possible to obtain chemical maps at the atomic scale using energy dispersive x-ray (EDX) analysis based on the x-rays emitted when core holes are filled post ionization. The inelastic cross section for EDX for a particular core-loss can be modelled as being proportional to that for an EELS experiment for the same ionization edge but for a detector spanning the whole solid angle and with an energy window which incorporates all energy losses above threshold. Z-contrast imaging, based on phonon excitation, has recently been put on a quantitative basis, with good agreement between theoretical simulations and experiment being demonstrated.

Images taken in conventional transmission electron microscopy (CTEM) based on elastic scattering and simulations have never agreed quantitatively. There is a large contrast mismatch, which has become known as the Stobbs factor, and which is typically between two and five. Besides complicating the interpretation of high-resolution transmission electron images, this discrepancy raises questions as to whether the current understanding of image formation is adequate. In STEM it is possible to operate the microscope under conditions which, by the quantum mechanical principle of reciprocity, are equivalent to those in CTEM.
The results of such an experiment will be presented which are in excellent agreement with theory for specimens up to 25 nm.

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