Structural and Elemental Analysis of Indium Doped Zinc Oxide Nanowire by Ultra-High Resolution STEM-EELS using Cs-Corrected

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One dimensional metal oxide nanostructures with superlattice structure have attracted much attention owing to their fascinating functional properties. Among them, In_2O_3-ZnO heterstructure nanowire is one of the most important materials for its potential applications in optical[1] and thermoelectric devices[2]. Here we report a trivalent In^{3+} ions in ZnO nanowire to form the inversion domain superlattices structure in homologous compound $RMO_3(ZnO)m$ system (R = Sc, In, Y, and La; M = In, Fe, Ga and Al; m = integer).

Monolayers of indium in inversion domain boundaries (IDBs) were investigated in an aberration-corrected scanning transmission electron microscope. The improvement of modern aberration-correcting technology can not only allow us to achieve sub-angstrom resolution imaging but also provide benefit to high resolution analysis by electron energy-loss spectrometry (EELS). The scanning-transmission electron microscopy-EELS (STEM-EELS) collects spectrum in every single probe position and form a spectrum image[3,4]. In this study, STEM-EELS analysis is applied to investigate of In_2O_3-ZnO heterstructure nanowire.

The structure and composition of IDBs were clearly visualized in HAADF - STEM imaging, giving rise to bright contrast because indium (Z_{In} = 49) is much heavier than the matrix elements Zn and O , as shown in Figure 1 . It is shown that indium additions are essentially located in monolayers within the IDBs, and EELS atomic column mapping imaging is capable of rapidly mapping the element distribution, as shown in Figure 2. Quantification of data acquired by EELS from well defined sample regions in STEM both confirm the assumption of one full monolayer of dopants per IDB.

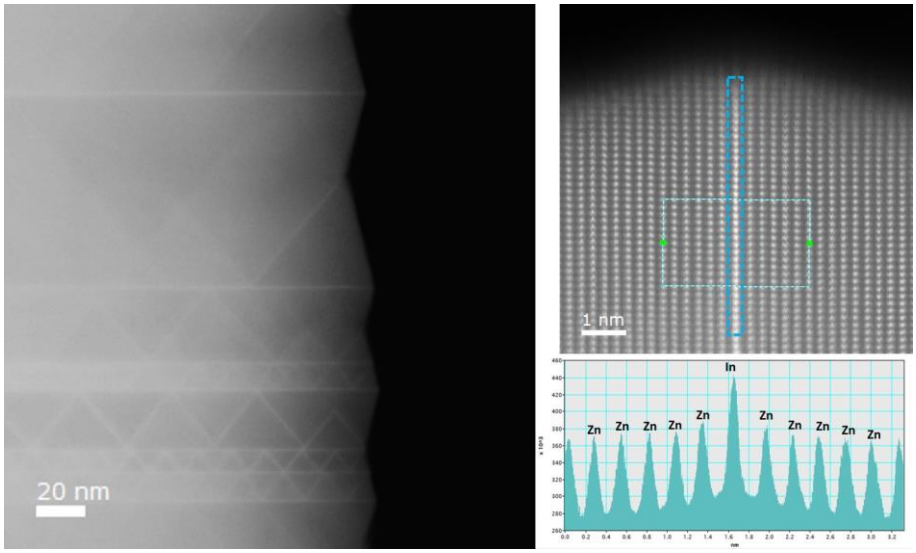

Figure 1. Atomic-resolution and low magnification HAADF-STEM image; columns of Zn and In cations are clearly resolved; weak signals from oxygen are not detectable.

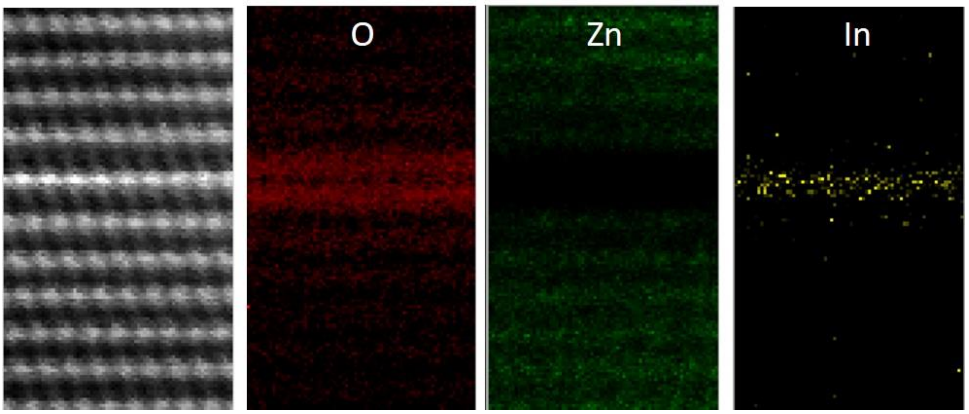

Figure 2. Atomic-resolution EELS mapping image of Zn and In element.

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