Low-kV EELS band gap measurements on indium monolayer structures in ZnO

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Zinc Oxide (ZnO) is a promising semiconducting material. Doping ZnO with In atoms is known to produce highly conductive ZnO, with demonstrated resistivity of about $9\times10^{-4}\Omega$cm for magnetron sputtered films [1]. However, similar doping with other group III elements, Al and Ga, reveal an order of magnitude lower resistivity [2], [3], as compared to In. In this work, we have used monochromated low-kV STEM to investigate In-doped ZnO films (Zn0.95In0.05O) deposited onto single crystal ZnO by magnetron sputtering, and show the spontaneous formation of In monolayers perpendicular to the c-direction.

STEM imaging at 300kV of wedged samples shows the precise nature and lateral size of the layers with hints to their three-dimensional geometry. Low loss EELS spectrum imaging made with a 60kV monochromated STEM probe is used to resolve the very low energy losses of the monolayers with high spatial-resolution. Changes to the band gap across the monolayers and into pristine ZnO are quantified and compared to previous research [4] - [7]. The origin of the monolayer structure is elucidated, and its potential future use for specialized semiconductor devices is discussed.

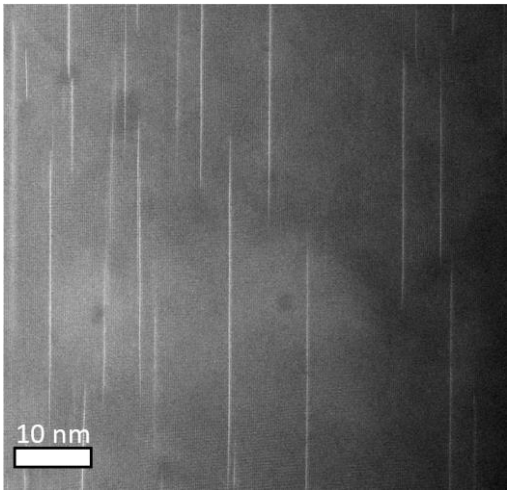

Figure 1. HAADF STEM image showing the indium monolayers

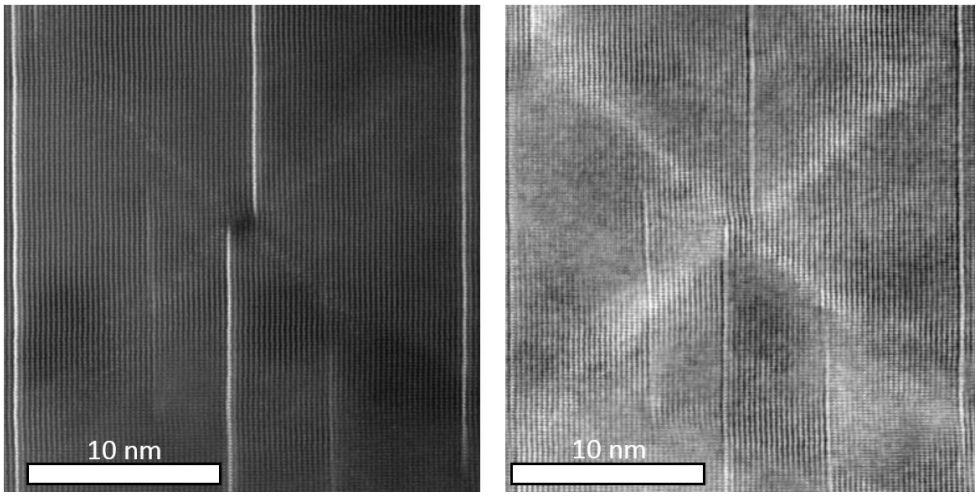

Figure 2. Simultaneously acquired ADF (left) and ABF (right) STEM images showing the resulting cross-shaped lattice strain from the adjacent termination of two monolayers

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