Electronic Supplementary Material (ESI) for Chemical Communications


# **Supporting Material**s for **Smooth ZnO Crystal Thin Film by Solution Hydrothermal Growth**

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1. Structure characterization using TEM

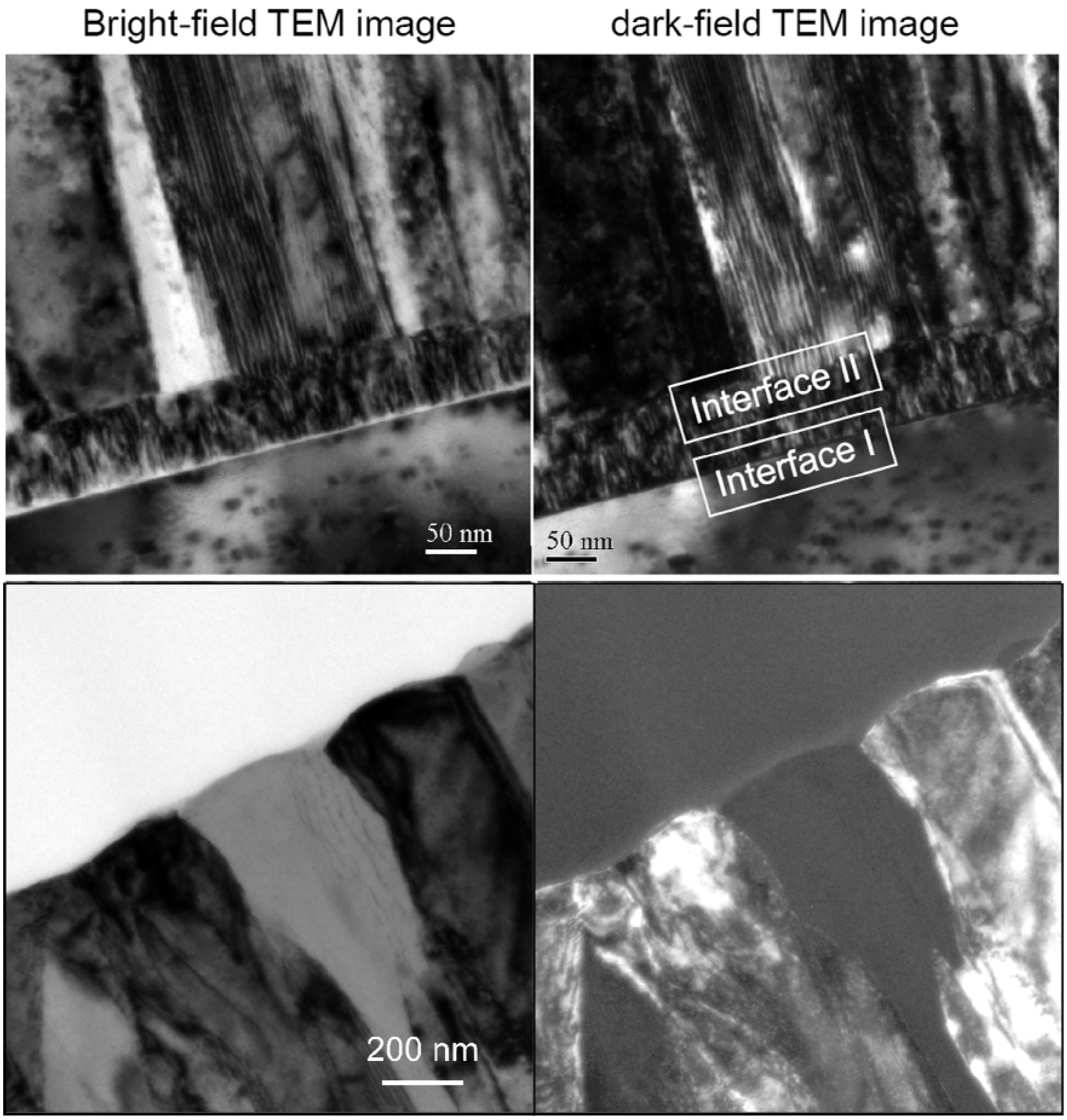


Figure s1: Bright field and dark field cross-section TEM images of the ZnO thin film.

Figure s1 show the cross section TEM images. Nucleation barrier is generally small leading to randomly oriented islands, for low temperature deposition on the seeding layer. The seeding layer is polycrystalline and shows the elongated particles with the grain size of a few nm in diameter and 10-20 nm in length, vertical to the sapphire surface. The ZnO nanocolumns are grown on the top of the seeding layer. The sizes of the nanorods increase gradually and continuously, leading to the coalescence into continuous thin film. The nanocolumns and large domains of the thin film show different contrast due the rotation unit cells along the c-axis.

Figure s2 show the bright field cross section TEM images of the coalesced ZnO thin film (top). The interfaces beteen and sapphire and ZnO sputtered seeding layer, the seeding layer and the ZnO columns can be clearly identified. The bottom images are the high-resolution micrographs. #1 to #4 label the different position of a particular nanocolumn from the ZnO seeding layer/sapphire interface to the merged columns. The clear interface between crystal sapphire and the ZnO can be seen in image #1. There is also a very thin layer of amorphous layer (less than 1 nm), on which the polycrystalline seeding layer is grown (as in image #2). Some voids are obervable (image #3) and the nanocolumns grow larger and merge into thin film. Image #4 clearly show the boundary between have crystalline nanocolumns, the nanocolumns are along the c-direction but with different rotations and clear lattice fringes can be only seen from one of the columns.

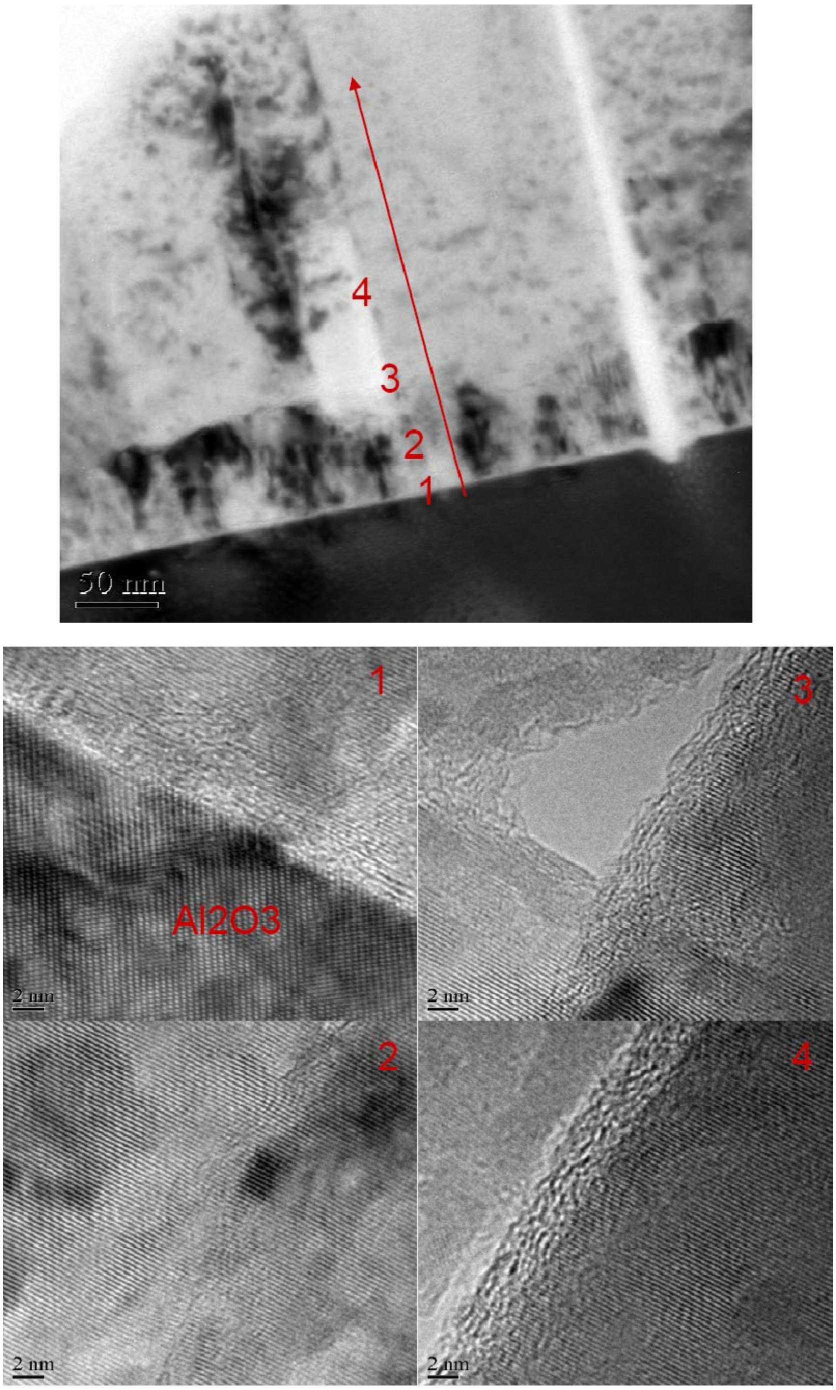


Figure s2: High resolution cross-section TEM images of the coalesced ZnO thin film. 1 to 4 labels the different position of a particular nanocolumn from the ZnO seeding layer/sapphire interface to the merged columns.

2. Optical transmission measurement

Room temperature transmittance study was conducted using a monochromator (Horiba Jobin Yvon model iHR 550) equipped with a 100 W halogen lamp (Osram 64628) and a 1200 groove/mm grating with 330 nm blaze. Illumination was incident at 90° to the sample surface with light spot size around 0.25 $cm^2$. A lock-in amplifier ($10^6$ V/A model SR530) was used to isolate the signal component arising specifically from the incident illumination. The light spectrum of the monochromatic illumination was calibrated using a silicon p-i-n photodiode (Newport model 818-UV with OD3 attenuator) with an effective measurement spectrum of 350-1100nm.