Electronic Supplementary Information

Direct growth of ZnO crystals on various Cu substrates by Cu-catalyzed chemical bath deposition

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Experimental

Chemical bath deposition of ZnO. All aqueous solutions were prepared using reagent-grade chemicals and deionized (DI) water (>10 MΩ cm) purified by a Millipore Elix Advantage 5 system. As a pure Cu substrate, (i) a polycrystalline Cu plate for Hull cell tests (67 × 100 × 0.3 mm, surface roughness (*R*a) = ~20 nm, Yamamoto-MS Co., Ltd.), (ii) a polished single-crystal Cu(111) plate (10 × 10 × 0.5 mm, *R*a < 3 nm, MTI Co.) and (iii) a Cu mesh (φ0.11 × 100 × 100 mm, 100 mesh, Nilaco Co.) were used. First, substrates (i) and (iii) were cut to a size of 15–30 × 50 mm as required. Prior to the deposition, these Cu substrates were cleaned by immersion in an alkaline degreasing solution (Ace Clean, Okuno Chemical Industries Co., Ltd.) at 50 °C for 5 min and then rinsed with DI water. ZnO was deposited by the immersion of the Cu substrate in an aqueous solution containing 5.0–160 mM $Zn(NO_3)_2 \cdot 6H_2O$ (≥99%, Nacalai Tesque, Inc.) and 3 mM dimethylamine borane (DMAB, ≥97%, Wako Pure Chemical Industries, Ltd.) at 80 °C for 0.5–1 h without agitation (the pH of the solution was ~5.8 at 25°C). The deposits were rinsed with DI water and dried under ambient atmosphere.

Characterization of ZnO. The morphology and crystal structure of ZnO were examined by field-emission scanning electron microscopy (FESEM, JEOL JSM6700F) and X-ray diffraction using Cu Kα radiation (XRD, Rigaku SmartLab). Photoluminescence (PL) spectra and Raman spectra were recorded on a microscopic laser Raman (PL) spectrometer (HORIBA LabRAM HR Evolution) using laser light with a wavelength of 325 nm and 532 nm, respectively.

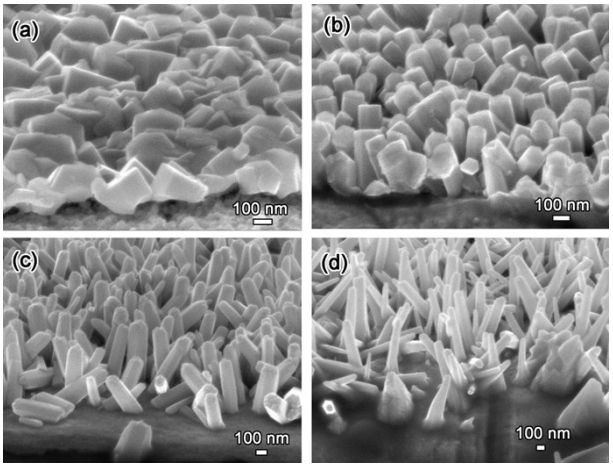

Figure S1. Tilt-view FESEM images of ZnO deposited on polycrystalline Cu plates by immersing in a $Zn(NO_3)_2$–3 mM DMAB aqueous solution at 80 °C for 30 min at different $Zn(NO_3)_2$ concentrations: (a) 160, (b) 80, (c) 20 and (d) 5.0 mM.

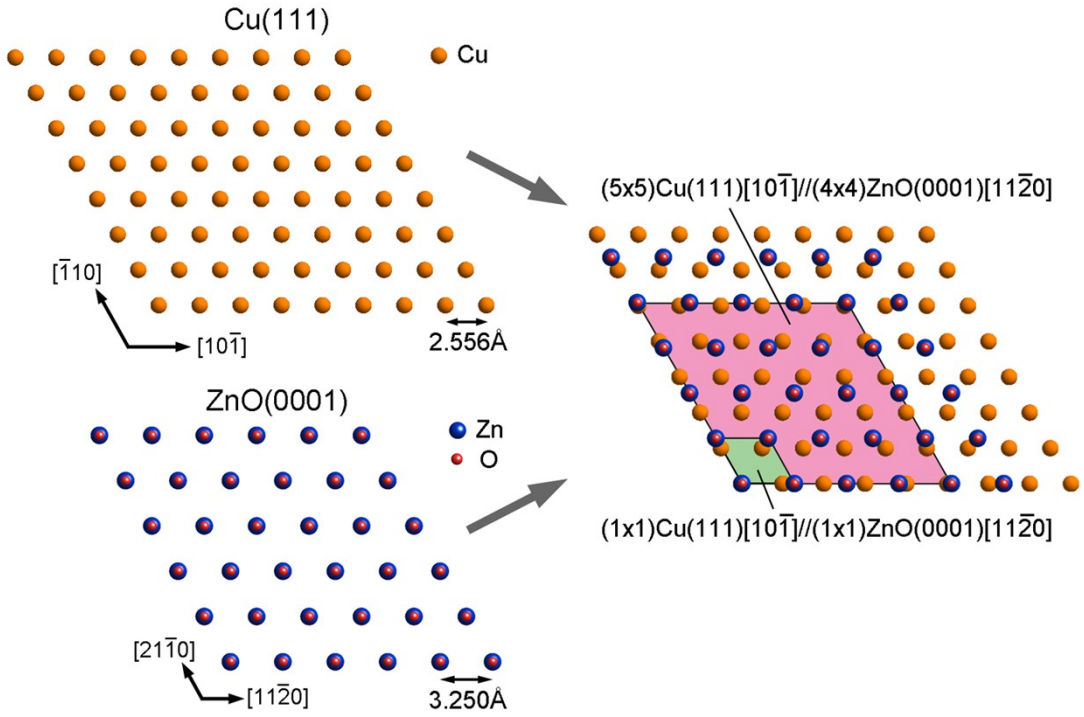

Figure S2. Schematic of the atomic arrangements for the Cu(111), ZnO(0001) planes and their overlap.

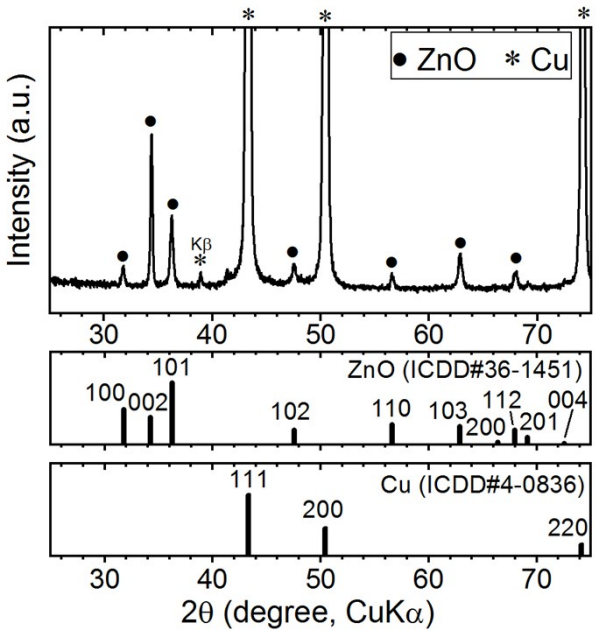

Figure S3. XRD pattern of ZnO obtained by immersing a Cu mesh in 5.0 mM $Zn(NO_3)_2$–3.0 mM DMAB aqueous solution.