Supplementary Material (ESI) for Chemical Communications

Electronic Supplementary Information

A method for covering a substrate with highly-oriented single crystalline hexagonal zinc structures under ambient pressure and room temperature

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A. Materials and experimental procedures

All chemicals used in this study were of analytical grade and were used without further purification. A 100 mL transparent aqueous solution containing 0.01 M zinc acetate dihydrate ($Zn(CH_3COO)_2 \cdot 2H_2O$, 99%, Samchun) and ammonia water (28.0~30.0 wt%, Samchun, 5 mL) was produced at room temperature (pH 11.37). To prepare the substrate, a 100 nm thick Al film was deposited as the reductant on a Si wafer by evaporation in a vacuum chamber. The substrate was transferred into the solution and maintained at 25 °C for 6 h. After the reaction, the substrate was removed from the solution and washed with deionized water, after which it was dried in an oven.

B. Characterizations

The morphology, crystallinity, crystalline nature, and chemical composition of the samples were determined by using a field-emission scanning electron microscope (FESEM, JEOL, JMS-7400F, operating at 10 keV), X-ray diffraction (XRD, Mac Science, M18XHF), a high-resolution scanning transmission electron microscope (Cs corrected HR-STEM, JEOL, JEM-2200FS with an energy-dispersive X-ray spectrometer, operating at 200 kV), X-ray photoelectron spectroscopy (XPS, VG Scientific, EscaLab 200iXL), Scanning tunneling microscope (STM, Digital Instruments, Nanoscope IIIa) and inductively coupled plasma atomic emission spectroscopy (ICP-AES, Spectro, SPECTRO FRAME MODULA E).

C. Al film characterizations

We characterized the Al deposited Si substrate before a reaction by using field-emission scanning electron microscope (FESEM), Scanning tunneling microscope (STM), X-ray photoelectron spectroscopy (XPS) and inductively coupled plasma atomic emission spectroscopy (ICP-AES).

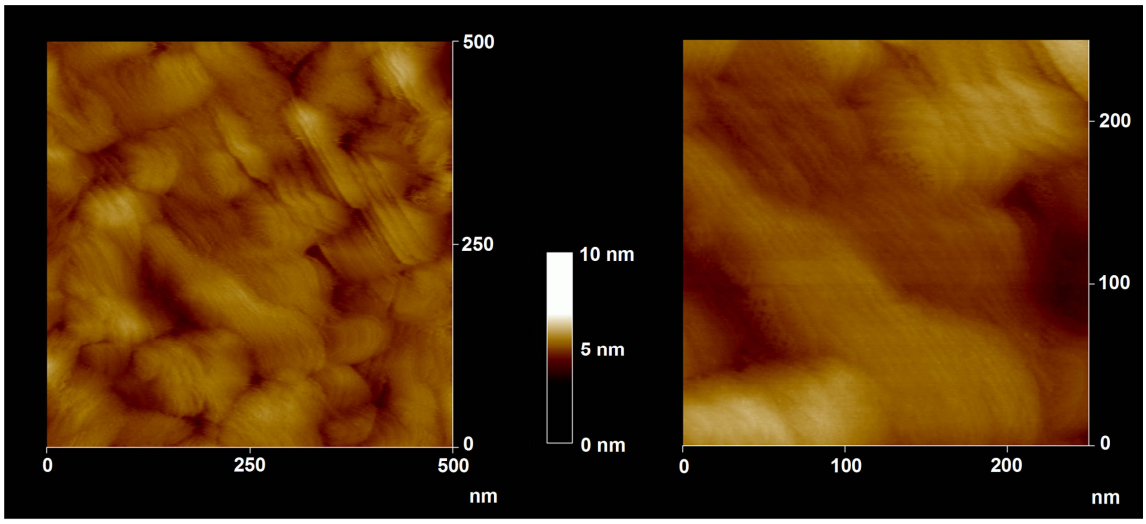

Fig. S1. STM image of the Al deposited Si substrate before a reaction.

Surface topology was characterized with STM (Fig. S1). The thickness of Al film deposited on the Si wafer is 100 nm ±5 nm (from SEM observations of substrate cross-section view). From XPS, the thickness of native oxide (~1.9 nm) was calculated using the Strohmeier Equation. Quantitative chemical analysis with (ICP-AES) revealed that the composition of Al film before a reaction has values of 98.88at.%: 1.12at%. (Al: O). Native oxides of the metal films consumed in replacement reactions, in which the more reactive component is consumed without any external electron source, have not been significantly considered.[C1,C2]

Reference

C1. L. A. Poter, Jr., H. C. Choi, A. E. Ribbe and J. M. Buriak, *Nano Lett.*, 2002, **2**, 1067.
C2. Y. Sun and Y. Xia, *J. Am. Chem. Soc.*, 2004, **126**, 3892.

D. XPS analysis of hexagonal zinc structures

We characterized the products after reaction with an aqueous ammonia solution containing Zn ions at 25 °C for 6 h by using X-ray photoelectron spectroscopy (XPS).

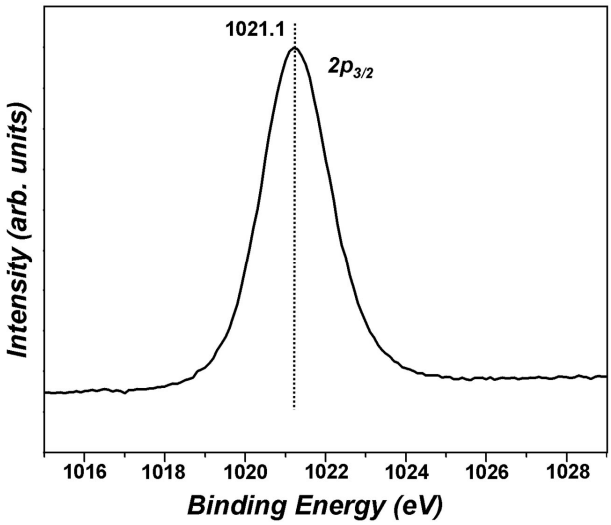

Fig. S2. X-ray photoelectron spectrum in the Zn 2p region of the products after reaction with an aqueous ammonia solution containing Zn ions at 25 °C for 6 h.

Fig. S2 shows an X-ray photoelectron spectrum in the Zn 2p region. The location of $2p_{3/2}$ peak (binding energy) indicates that Zn species in the products dominantly exist as Zn(0), not Zn(II).[D1,D2]

References

D1. J. Cheon, L. H. Dubois and G. S. Girolami, *Chem. Mater.*, 1994, **6**, 2279.
D2. Y. Zhu, H. Wang and P. P. Ong, *J. Phys.: Condens. Matter*, 2001, **13**, 787.

E. High-angle annular dark-field scanning transmission electron microscope (HAADF-STEM) image

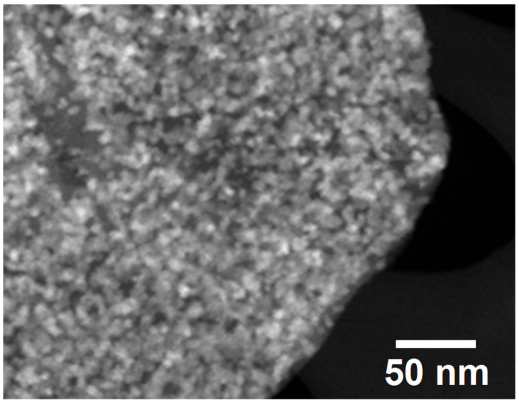

Fig. S3. A HAADF image of a Zn structure obtained after reaction with an aqueous ammonia solution containing Zn ions at 25 °C for 20 min.

The HAADF image (Fig. S3) shows that the structure, which was synthesized after reaction with an aqueous ammonia solution containing Zn ions at 25 °C for 20 min, is composed of nanoparticles.