

Supporting Information

Controlled growth of well-aligned ZnO nanorod array using a novel solution method

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SI-1 ZnO nanorods growth on zinc coated soda-lime glass.

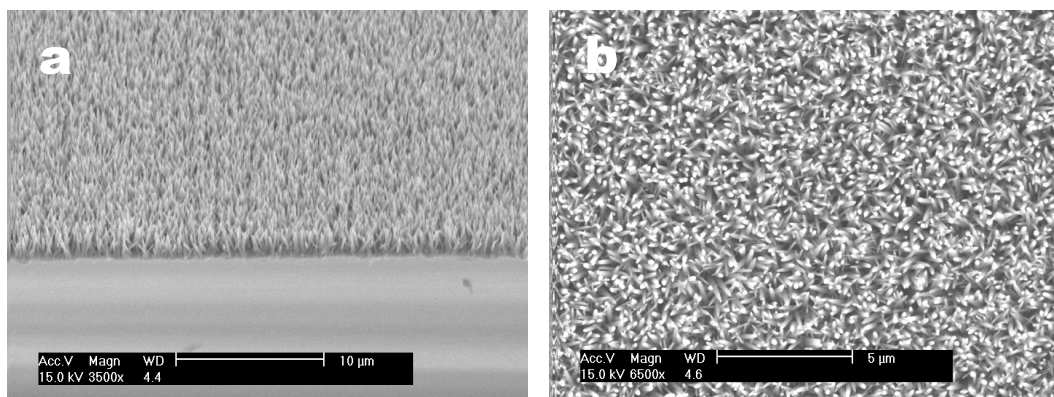


Figure S1. SEM images of ZnO nanorods grown on glass substrate (a) edge tilt view and (b) top view.

Note :

- 1) Soda-lime glass substrate was used after sonification cleaning for 30min in acetone.
- 2) 40nm-thick zinc metal evaporated on the glass substrate.
- 3) 80ml of 20mM (zinc ion concentration) / 2ml (vol. of added 28 wt% ammonia water) solution was used.
- 4) The growth temperature and time was 90 °C and 6h, respectively.

SI-2 Zinc seed effects.

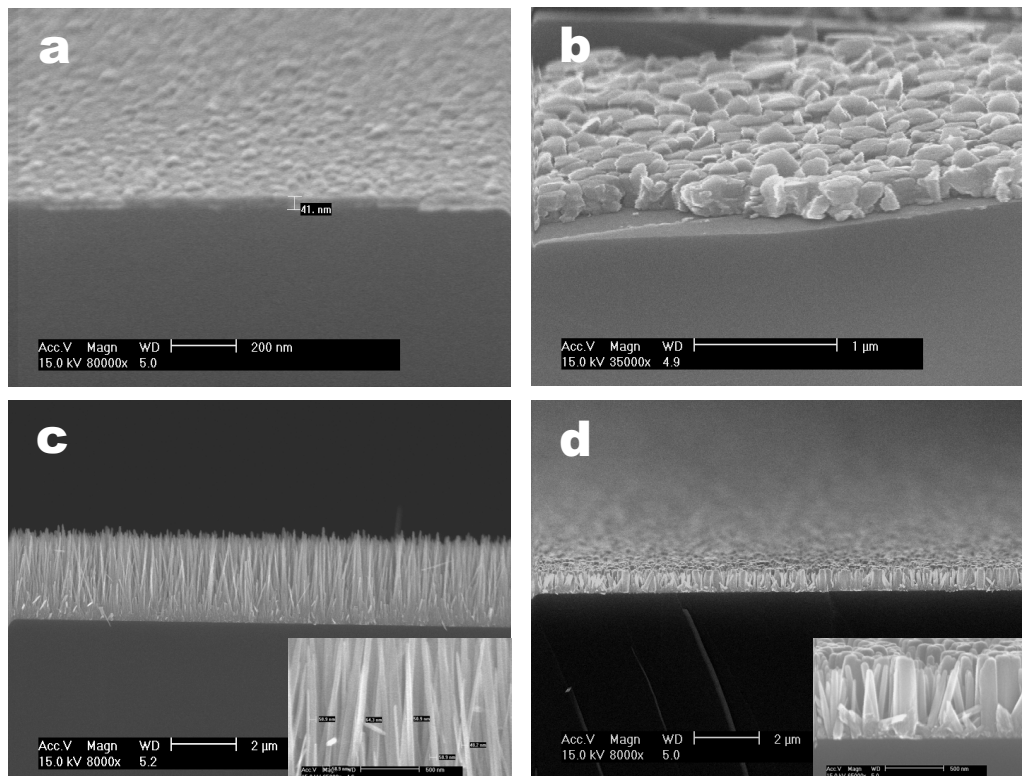
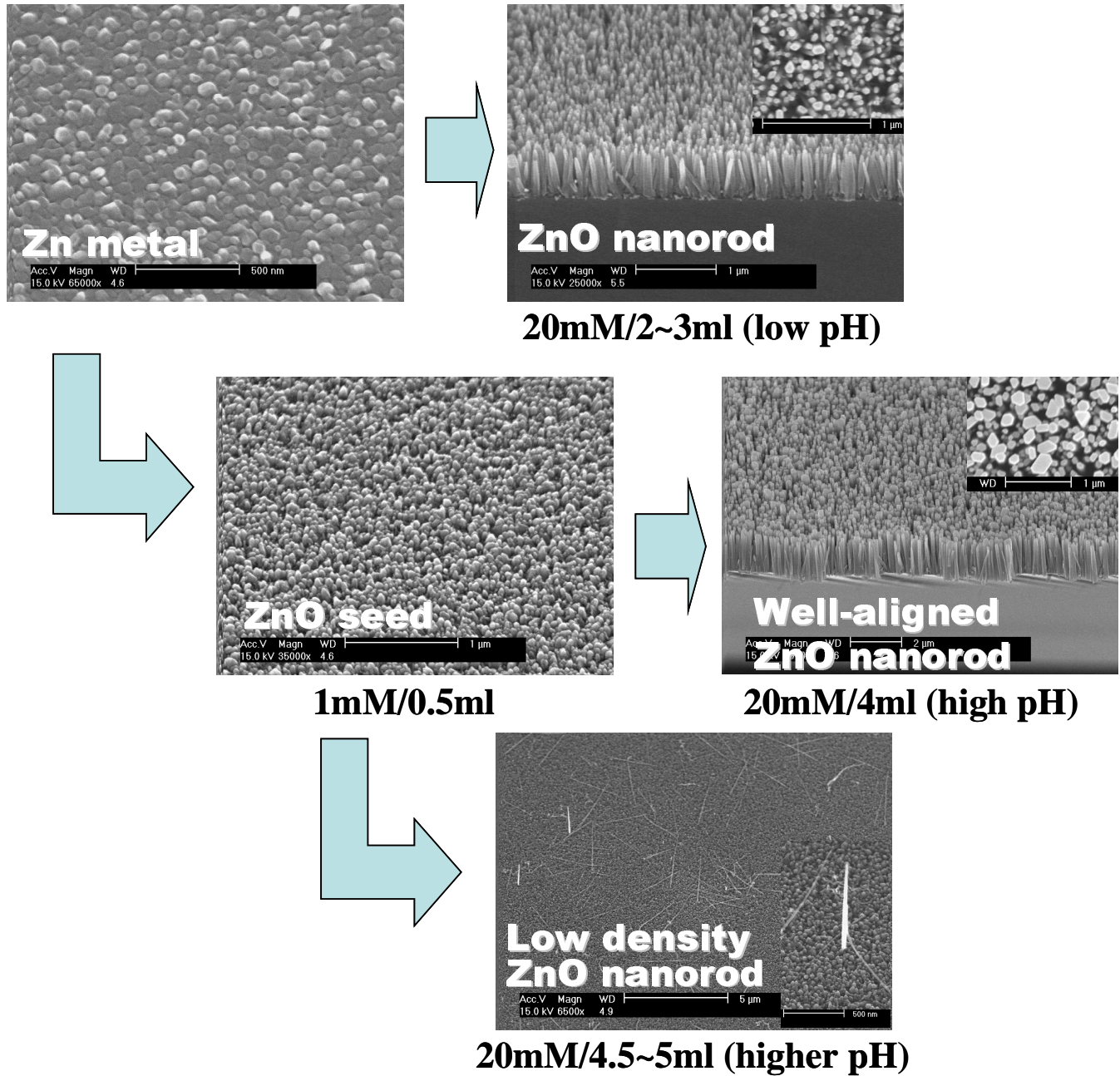


Figure S2. SEM images of Zn/Si substrate (a, b) and grown ZnO nanorods (c, d). The thickness of zinc layer was (a) ~ 40 nm, (b) ~ 230 nm. ZnO nanorods grown on (c) Zn(40nm)/Si substrate using 20mM/2.5ml solution and (d) Zn(230nm)/Si substrate using 20mM/2ml solution. Insets of (c), (d) show magnified images. The growth temperature and time was 90 °C and 6h, respectively.

Note : Sample (b) has larger zinc metal grain than (a) and also the sample (d) shows larger diameters of ZnO nanorods than those of sample (c).

SI-3 Growth control chart.



Note :

- 1) “ x mM / y ml” means y ml of 28 wt% ammonia water added to 80mL of x mM zinc salt aqueous solution.
- 2) For all cases, the growth temperature and time was 90 °C and 6h, respectively.
- 3) Zinc metal can be applicable only at low pH solution (10 ~ 10.4).

- 4) ZnO seed can be formed at the dilute solution (1mM/0.5ml).
- 5) High pH solution can be applicable to ZnO seed substrate.
- 6) The alignment of ZnO nanorods was enhanced when ZnO seed process was introduced.
- 7) At higher pH conditions (~ 10.8), there only grew low density of ZnO nanorods.

SI-4 Stepwise, digitalized growth.

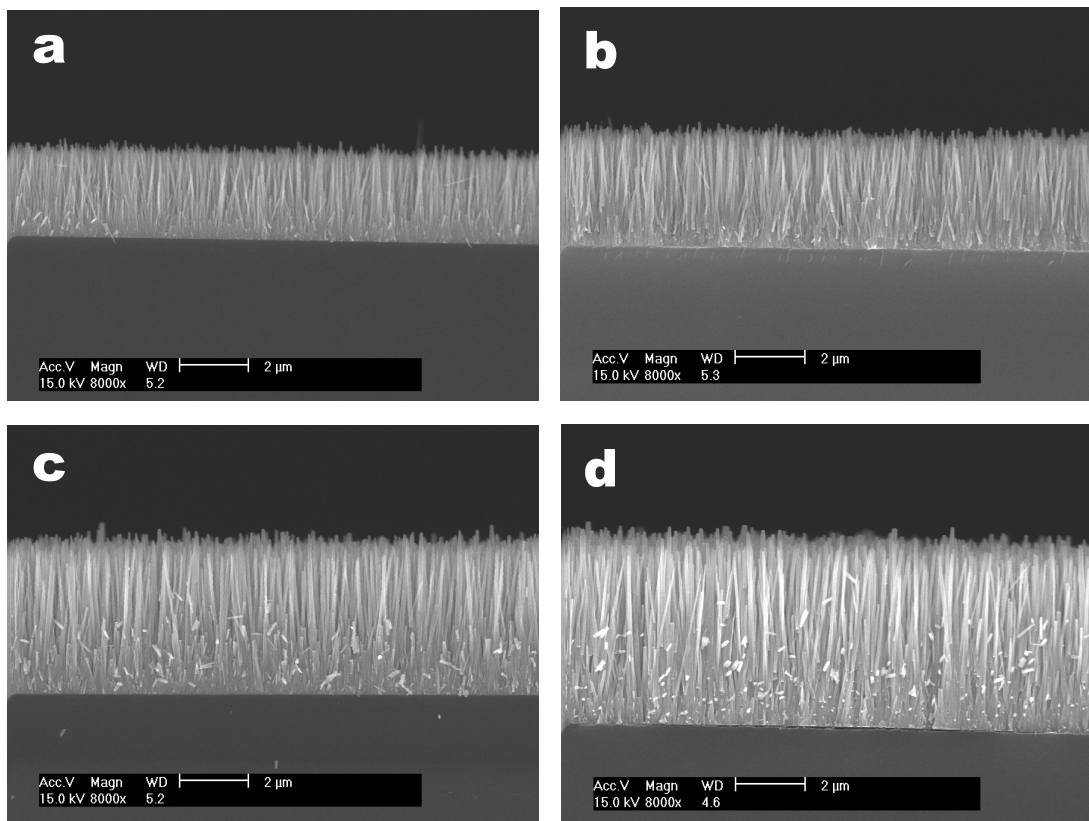


Figure S4. Raw SEM images of multi-step grown ZnO nanorod array on Zn/Si substrate (a) as-grown, (b) after 1st growth, (c) after 2nd growth, (d) after 3rd growth. All images were of same magnification (8000X).

Note :

- 1) As-grown ZnO substrate was prepared using Zn(40nm)/Si substrate and 20mM/2.5ml solution at 90 °C after 6h growth.
- 2) 1st growth was performed using as-grown ZnO nanorods substrate (Figure S4a sample) and 10mM/2ml solution at 90 °C during 6h.
- 3) 2nd and 3rd growth were performed at the same conditions as 1st growth step using the substrate prepared by previous growth step.

SI-5 ZnO nanorod growth using sequential two-steps: effects of solution concentration.

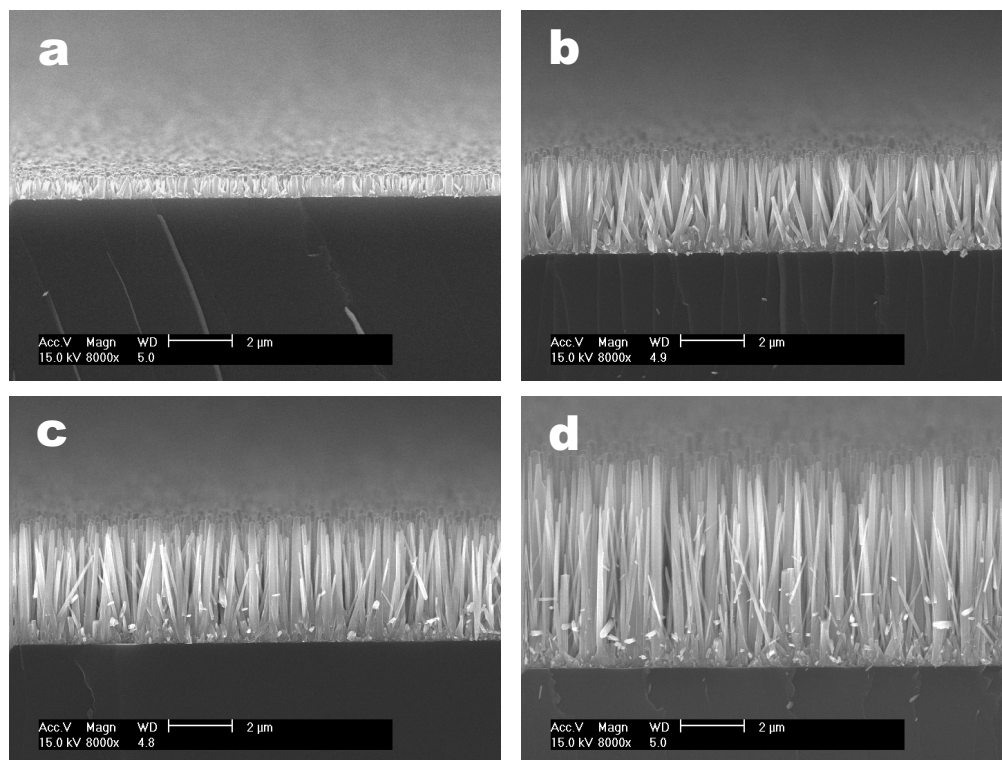


Figure S5. SEM images of the ZnO nanorods: (a) as-grown nanorods using 20mM/2ml solution and subsequently grown ZnO nanorods on the as-grown nanorods using (b) 10mM/2ml, (c) 20mM/3ml (d) 30mM/4ml solution, respectively. The magnification of the images was same as 8000 \times .

Note :

- 1) We prepared as-grown ZnO nanorods on Zn(230nm)/Si substrates using 20mM/2ml solution. After dividing the ZnO nanorods substrate into the three equal parts, we performed the next growth reactions with three samples, respectively, using three different solutions, 10mM/2ml, 20mM/3ml, 30mM/4ml.
- 2) The growth temperature and time was fixed to 90 °C and 6 h, respectively.
- 3) As mentioned in supporting information 2, the ZnO nanorods grown on larger grain sized zinc metal layer has larger diameter. The large diameter of the as-grown ZnO nanorod (Figure S5a) was succeeded to the following growth step (Figure S5b ~ d).
- 4) Higher zinc salt concentration produces longer nanorods.
- 5) Size of the subsequently grown ZnO nanorods could be controlled by adjusting the zinc salt concentration and pH of the solution.