Electronic Supplementary Material (ESI) for RSC Advances.

Supplementary Information

Controlled growth of aligned GaN nanostructures: from nanowires, needles to micro-rods on a single substrate

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S1-S2. Transmission electron microscopy (TEM) analyses of nanowire and pyramid from sample A.

Fig. S1(a) shows the top view SEM image of the nanowires from sample A (point 3#). The growth directions of nanowires were marked by the red arrows. Fig. S1(b) shows the TEM analyses of a nanowire. The high-resolution TEM (HRTEM) image (Fig. S1(c)) and the corresponding Fast Fourier transform (Fig. S1(d)) indicate that the nanowire has a wurtzite structure with a growth direction of [10-10]. The top view SEM image and the TEM image indicate that the nanowires grow along three <01-10> directions, which agrees with previous report. [Huang et al., J. Am. Chem. Soc. 2010, **132**, 4766]

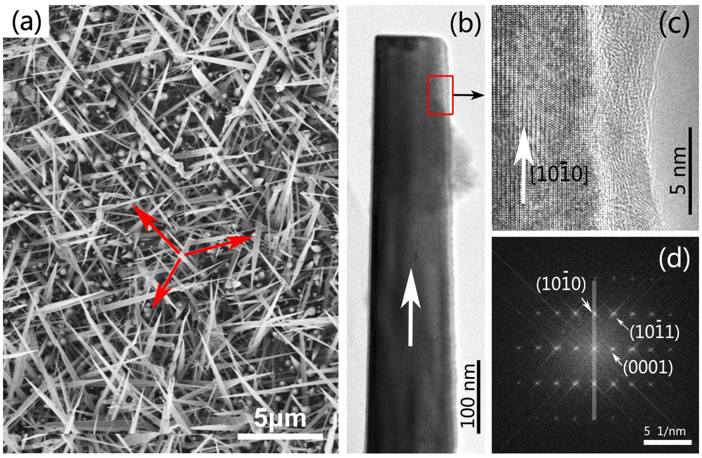

Fig. S1. (a) the top view SEM image of the nanowires from sample A. The grow directions of nanowire were marked by the red arrows. (b) the TEM image of a GaN nanowire, (c) the HRTEM image of the red square area (the growth direction was marked by the white arrow). (d) the corresponding Fast Fourier transform (FFT) of the HRTEM image.

Fig. S2(a) shows the TEM images of a pyramid from sample A (point 4#). The HRTEM image (Fig. S2(b)) and the corresponding SAED (Fig. S2(c)) indicate that the pyramid has a wurtzite structure with a growth direction of [0001].

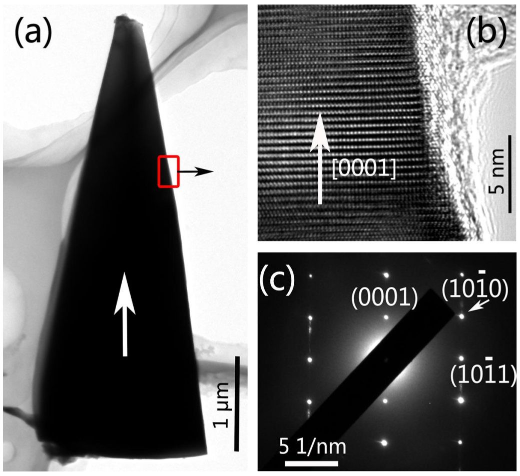

Fig. S2. TEM analyses of a hexagonal pyramid from sample A. (a) TEM image of a hexagonal pyramid, (b) the HRTEM image of the red square area. The growth direction was marked by the white arrow. (c) the corresponding SAED of the HRTEM image.

S3-S4. The TEM analyses of the triangular needle and hexagonal rod from sample B1.

Fig. S3(a) shows the TEM analyses of a triangular needle (point 1# of sample B1). The HRTEM image (Fig. S3(b)) and the corresponding SAED (Fig. S3(c)) indicate that the needle has a wurtzite structure with a growth direction of [10-10].

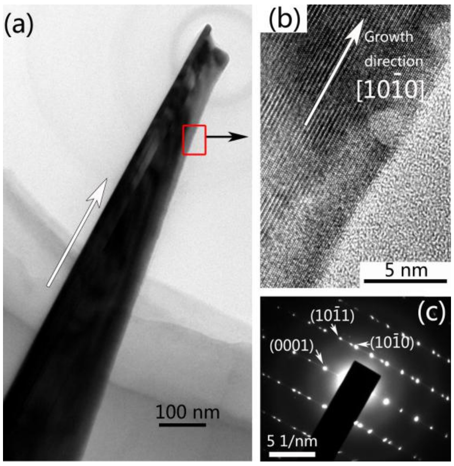

Fig. S3. TEM analyses of the needle from sample B1. (a) TEM images of a GaN needle, (b) the HRTEM image of the red square area. The growth direction was marked by the white arrow, (c) the corresponding SAED of the HRTEM image.

Fig. S4(a) shows the TEM images of a hexagonal rod (point 2# of sample B1), the HRTEM image (Fig. S4(b)) and the corresponding SAED (Fig. S4(c)) indicate that the rod has a wurtzite structure with a growth direction of [0001].

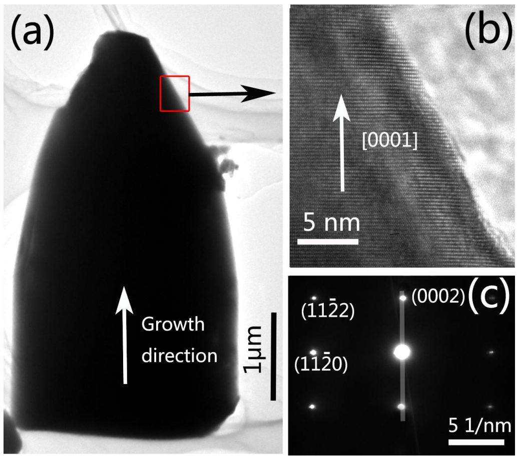

Fig. S4. TEM analyses of the needle from point 2# of sample B1. (a) TEM images of a GaN rod, (b) the HRTEM image of the red square area. The growth direction was marked by the white arrow, (c) the corresponding SAED of the HRTEM image.

S5. The TEM analyses of the hexagonal rod from sample B2.

Fig. S5(a) shows the TEM images of a hexagonal rod of sample B2, the HRTEM image (Fig. S5(b)) and the corresponding SAED (Fig. S5(c)) indicate that the rod has a wurtzite structure with a growth direction of [0001].

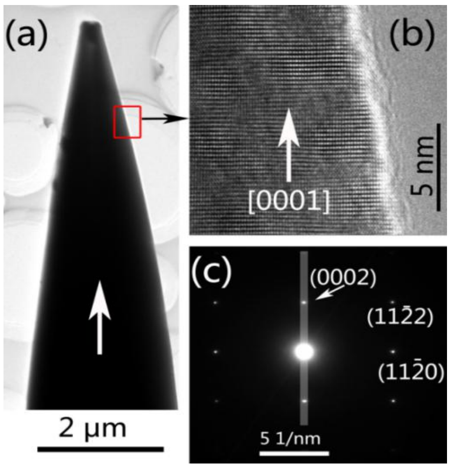

Fig. S5. TEM analyses of the rod from sample B2. (a) TEM images of a rod, (b) the HRTEM image of the red square area. The growth direction was marked by the white arrow, (c) the corresponding SAED of the HRTEM image.

S6. The X-ray diffraction spectra of sample B1, sample B2 and substrate.

The X-ray diffraction (XRD) patterns of sample B1, sample B2 and the substrate are shown in Fig. S6. There are four main peaks in the XRD spectrum. Three peaks corresponding to the (0002), (0004) and (10-10) planes of wurtzite GaN were observed. Another peak was corresponding to the (0006) plane of Al_2O_3 substrate.

The (0002) and (0004) peaks should be resulted from (0001) GaN substrate and GaN rod, which grows perpendicular to the (0001) GaN substrate. The (10-10) peak should be resulted from [10-10] GaN needles, which is greatly reduced in the spectrum of sample B2 (which mainly contains rod) and almost disappear in the spectrum of substrate. The growth direction measured by XRD agrees well with that measured by TEM mentioned above.

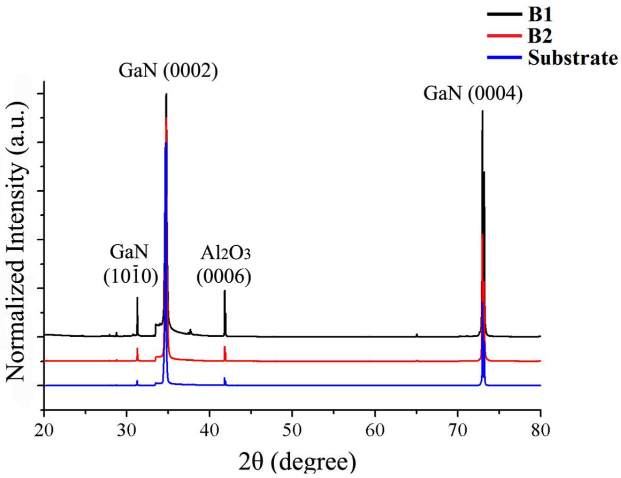

Fig. S6. The XRD pattern of the sample B1, sample B2 and substrate.

S7. The photoluminescence (PL) spectra of nanowires, needles and micro-rods.

Fig. S7 shows the PL spectra of three nanostructures: nanowires (sample A), needles (sample B1) and micro-rods (sample B2) measured at room temperature. There are three major peaks in the spectra, i.e., (1) the 365nm peak, which was corresponding to the band-edge emission of hexagonal GaN, (2) the peak at 387 nm, which may be resulted from the excitons bound to surface or other structure defects [Korotkov et al., Physica B, 1999, **80**, 273], (3) the peak at 570 nm, which is deep-level transitions associated with structural defects and impurities [Jain et al., J. Phys.Chem. B, 2004, **108**, 12024-12026]. The band-edge emission peaks of needles and micro-rods were sharper than that of nanowires, they have good optical properties.

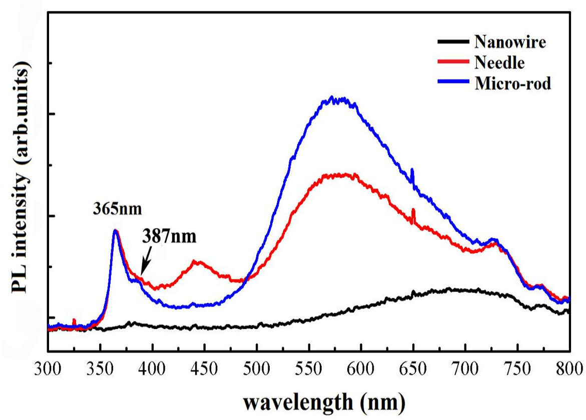

Fig. S7. The PL spectra of (a) nanowires, (b) needles and (c) micro-rods.