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Supporting Information

From bulk to porous GaN crystal: precise structural control and its application in ultraviolet photodetectors

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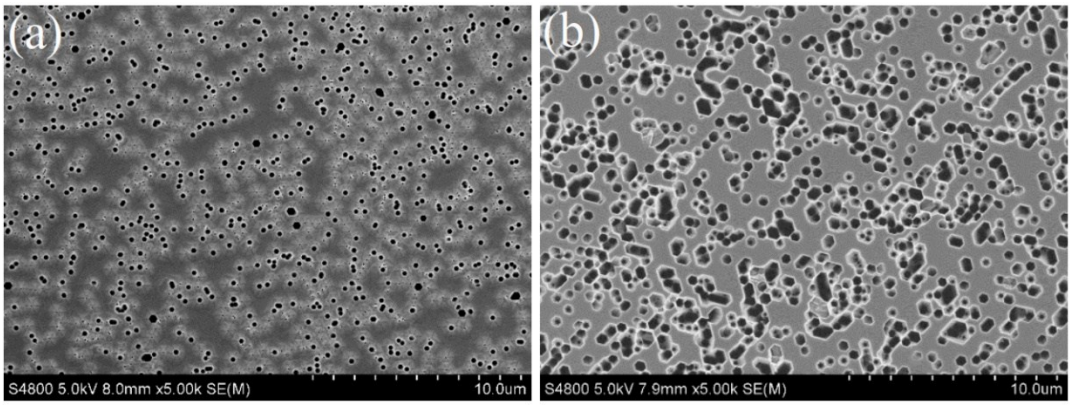

Figure S1. SEM images of GaN samples annealed at (a) 1050°C, (b) 1150°C for 60 min.

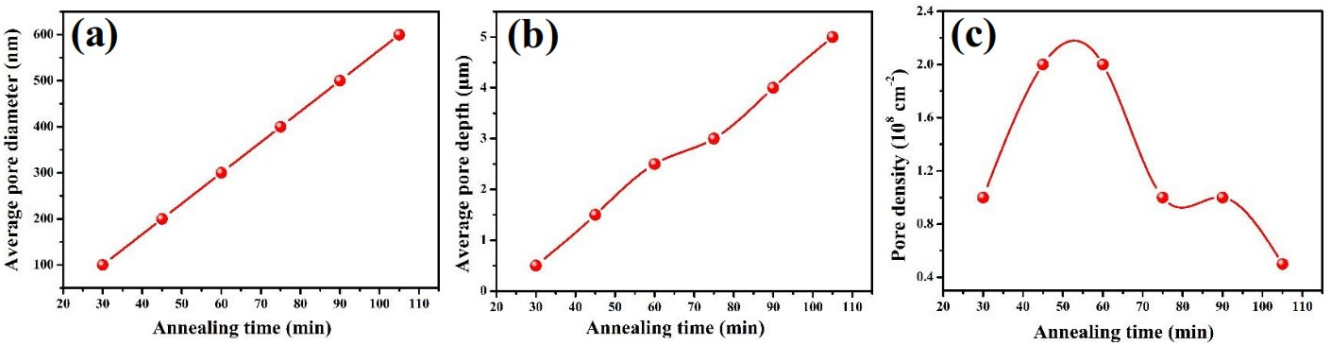

Figure S2. Average pore diameter (a), average pore depth (b), and pore density (c) of porous GaN plotted as a function of annealing time at 1150°C.

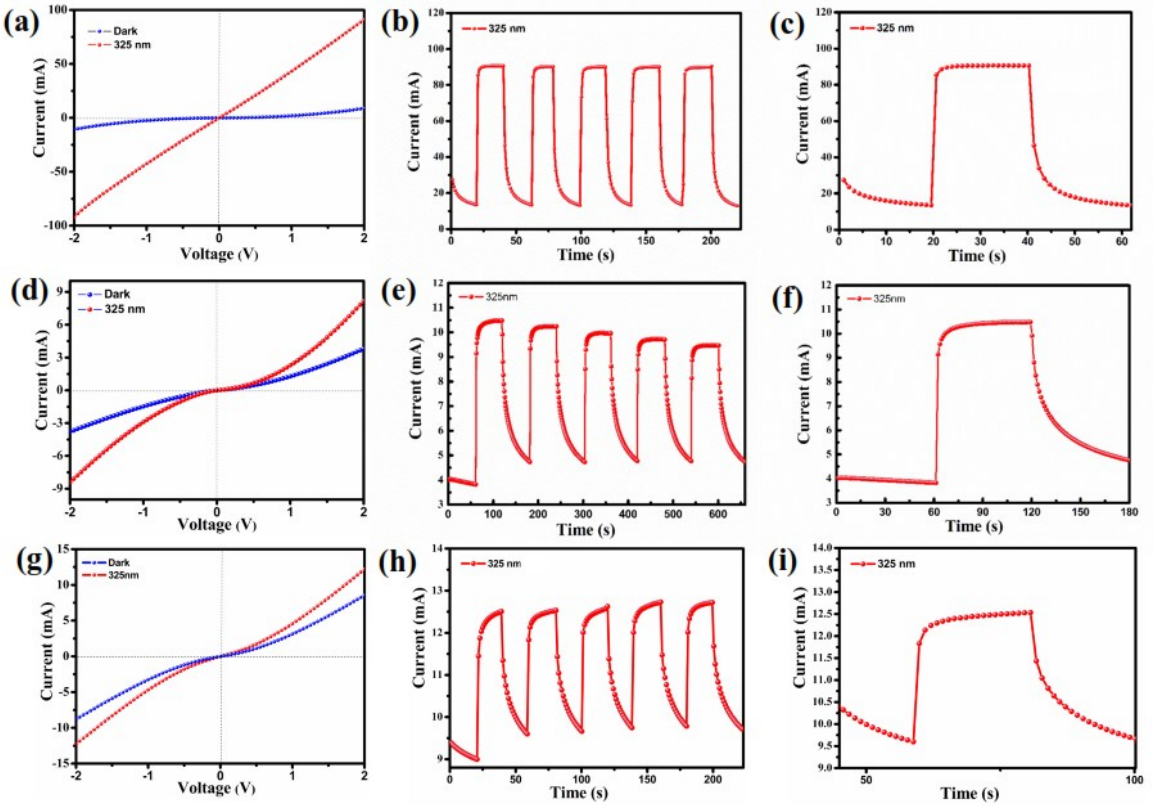

Figure S3. The I-V curves of phototdetectors based on porous GaN annealed at (a) 900°C, (d)1100°C, and (g)1200°C, respectively. Time responses of the photodetectors based on porsou GaN annealing at (b) 900°C, (e)1100°C, and (h)1200°C, respectively. Enlarge view of the current rise and decay processes of the photodetectors based on porous GaN annealed at (e) 900°C, (f)1100°C, and (i)1200°C, respectively.

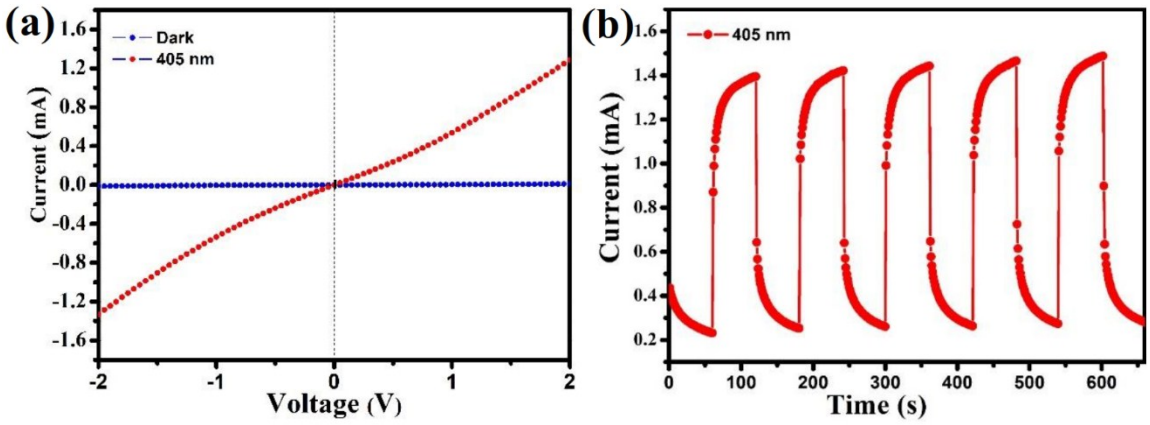

Figure S4. (a) The *I-V* curves of porous GaN (annealing at 1000℃) device under dark and UV-light illumination with 405 nm laser. (c) Time response (*I-t* curve) of the porous GaN (annealing at 1000℃) photodetector with 405nm laser.

Table S1 Photoelectrical performances of the fabricated porous GaN (annealing at 1000℃) photodetectors at 2 V bias voltage with 325 nm and 405 nm laser, respectively.

UV-light (nm)	Photocurrent (mA)	Rise time (s)	Decay time (s)
325	3.20	1.524	1.553
405	1.287	5.680	14.174

The FWHM of the HRXRD rocking curve for asymmetrical (102) plane is directly related to the reliability of the structural quality since (102) FWHM is related with all TDs, including pure edge-, screw- and mixed-dislocations[1]. The dislocation density ρ can be calculated by the following formula[2]:

$$\rho = \frac{\beta^2}{4.35 \times b^2}$$

Where β is the absolute value of the Burgers vector and b stands for the FWHM of the rocking curves. The defect density calculated from the FWHM of the rocking curve is as follows:

Table S2 Defect densities calculated from the FWHM of the rocking curves.

Annealing temperature (℃)	FWHM of (102)	Dislocation density ($\times 10^8$ cm^{-2})
900	278	4.11
1000	273	3.96
1100	257	3.51
1200	307	5.01

When the annealing temperature is 1000 ° C and 1100 ° C, the pore size of the GaN is not large, and there is no merging among the pores, so the pore density obtained under this annealing condition is closest to the actual dislocation density. The pore density of porous GaN samples annealing at 1000 ° C and 1100 ° C is about 2×10^8 cm $^{-2}$, which also confirms that the pore density corresponds to the defect density of the porous GaN.

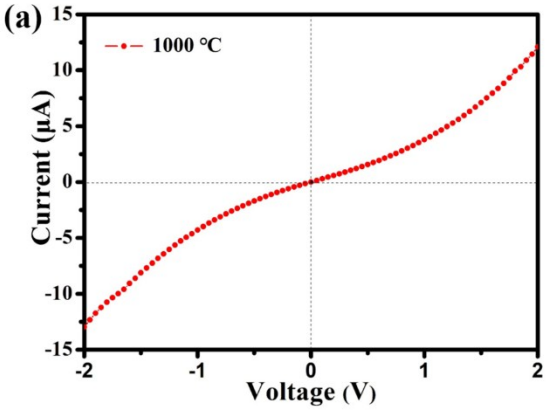

Figure S5a Enlarged view of the dark current I-V curve in Figure 5b of the manuscript.

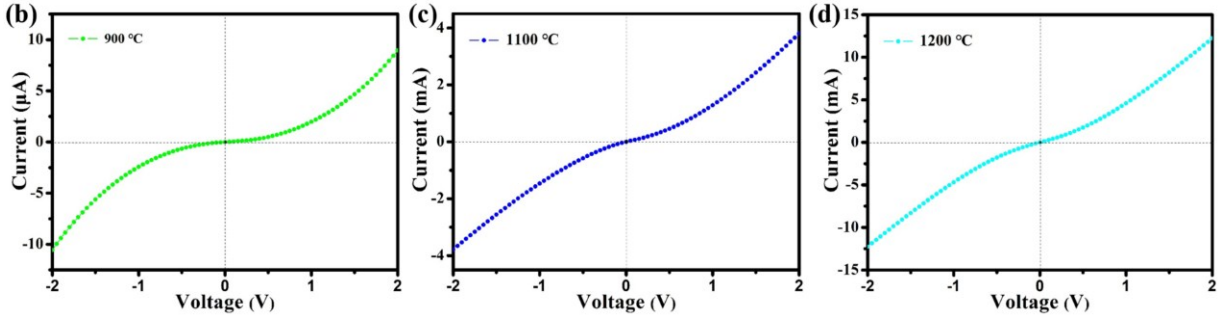

Figure S5 Enlarged view of the dark current of the UV photodetectors based on porous GaN annealing at (b) 900 °C , (c) 1100 °C, and (d) 1200 °C, respectively.

The above Figure S5a is an enlarged view of the dark current I-V curve in Figure 5b of the manuscript. As shown in Figure S5a, it can be seen that the I-V curve is not completely linear relationship and therefore it is not an ohmic contact but a Schottky contact. Figure S5b, c, d are enraged view of the dark current of the UV photodetectors based on porous GaN annealing at 900 °C, 1100 °C, and 1200 °C, respectively. It can be seen that they are all not linear relationships and are Schottky contacts.