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Supporting Information

Preparation of Controllable Double-Selective Etched Porous Substrate for HVPE Growth of GaN Crystals with Excellent Optical Properties

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1. Effect of etchant concentration, reaction time and reaction temperature on selective etching

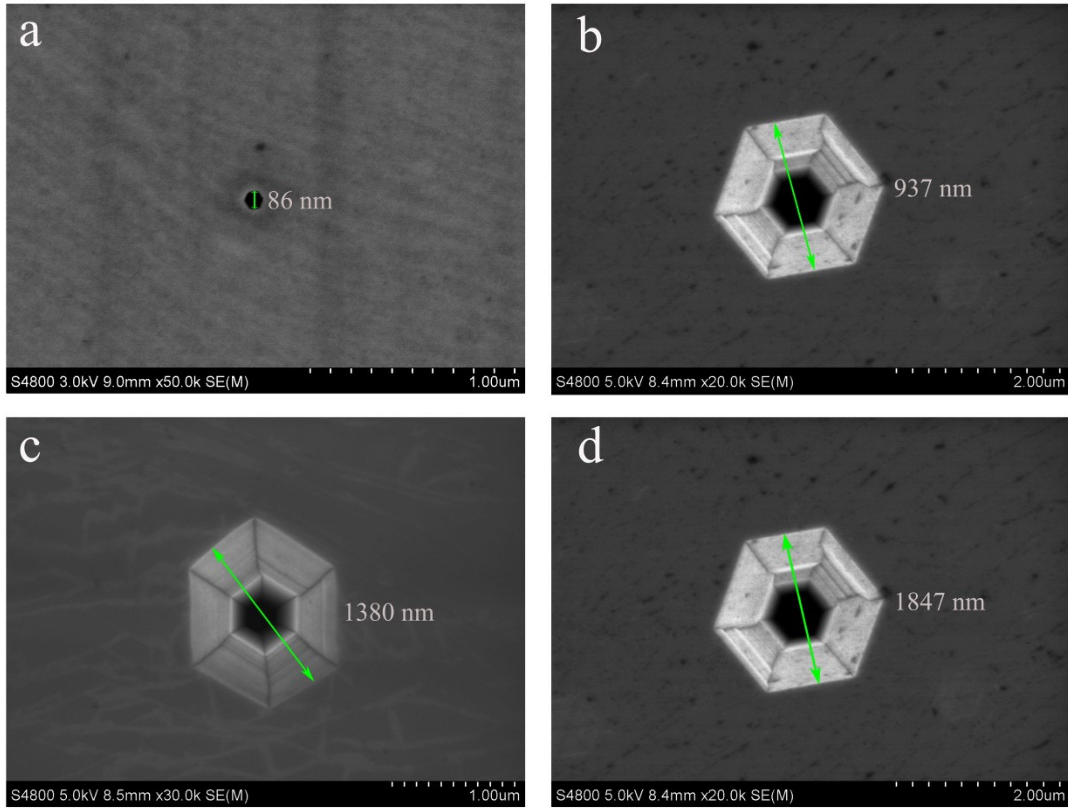

Fig. S1 Selective etching of the phosphoric acid etching solution with different volume concentrations at 150°C for 150 min, (a) 25%, (b) 35%, (c) 45% and (d) 55%.

The corrosion pit size increased from 86 nm to 1847 nm as the concentration of the reaction solution increased.

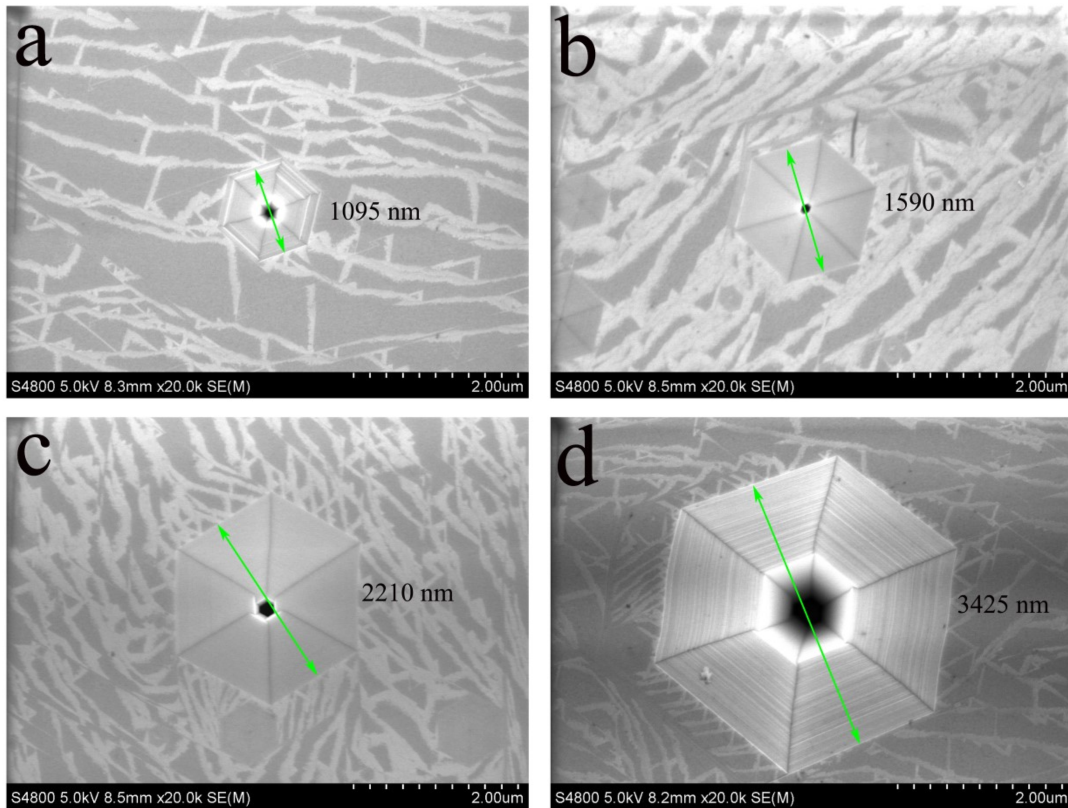

Fig. S2 Selective etching of different reaction times at 150°C in 35% phosphoric acid, (a) 150 min, (b) 180 min, (c) 210 min and (d) 240 min.

The corrosion pit size increased from 1095 nm to 3425 nm with increasing reaction time.

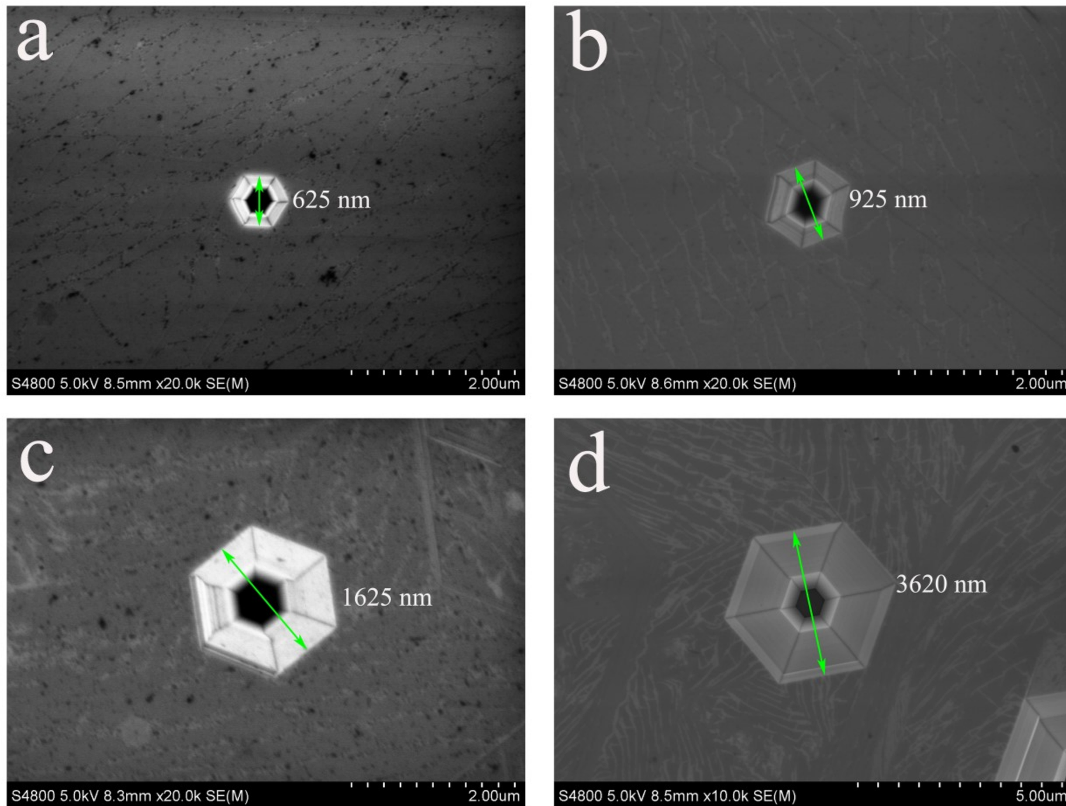

Fig. S3 Selective etching after 150 min at different reaction temperatures in 35% phosphoric acid, (a) 140°C, (b) 150°C, (c) 160°C and (d) 170°C.

The corrosion pit size increased from 625 nm to 362 nm as the reaction temperature increased.

As can be seen from Fig. S1, S2 and S3, there are significant differences in the results of the double etch etching of different etchant concentrations, reaction times and reaction temperatures. By controlling these variables, the etch rate and the degree of etching can be flexibly controlled to meet various needs.

2. The growth on the HMGA substrate to obtain the GaN single crystal

Fig. S4 (a) Ga surface grown on HMGA substrate to obtain GaN single crystals, (b) N surface grown on HMGA substrate to obtain GaN single crystals, (c) GaN single crystal thickness is 3 mm.

3. High resolution XPS profiles

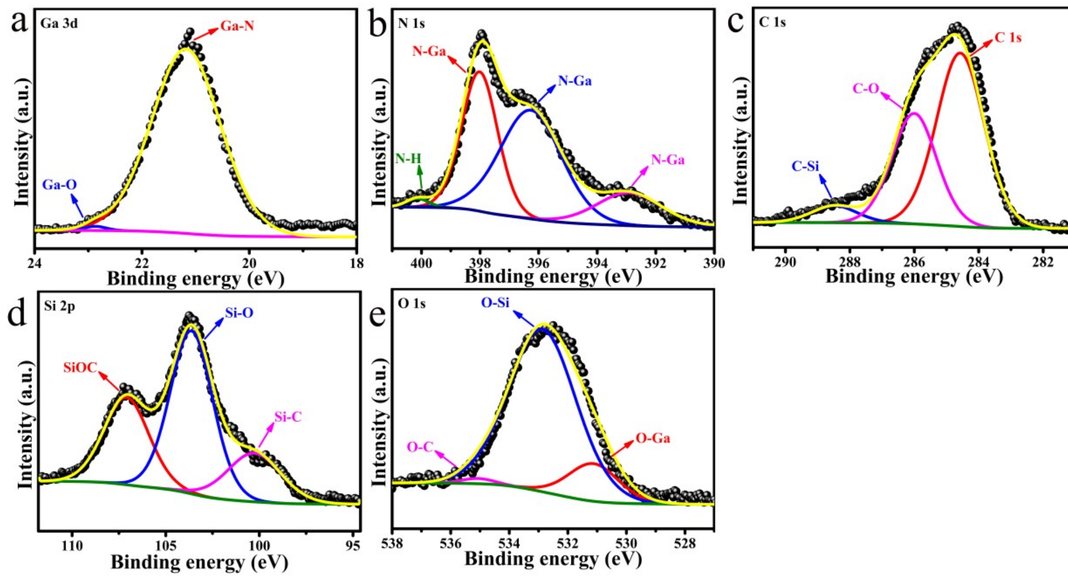

Fig. S5 High resolution XPS profiles (a) Ga 3d, (b) N 1s, (c) C 1s, (d) Si 2p and (e) O 1s.

4. SEM test results of Ti mask and Au mask

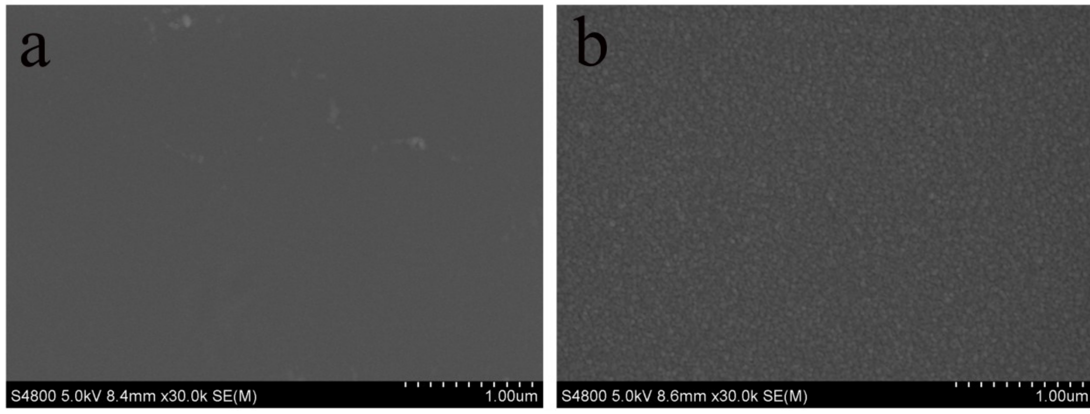

Fig. S6 (a) 10 nm Ti mask and (b) 40 nm Au mask.