Surface Texturing of GaN Light Emitting Diode by Nano-patterned Block Copolymers

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A lot of progress has been made on GaN-based devices for optoelectronic applications such as Light emitting diodes (LED) and blue laser diodes (LD). As the growth technique matures, it is now issue to minimize the reflection at the surface of GaN by surface roughening. KOH wet-etching has been employed to roughen the surface of GaN, but it is extremely difficult to control the etch-rate because the wet etch-rate depends on so many factors. Therefore, wet-etch technique is undesirable in terms of reproducibility.

For dry-etching, it is expensive to pattern 2 inch or 3 inch wafers using E-beam lithography to make nano-sized pattern on the surface of GaN. Alternatively, we employed self-assembled PS-*b*-PMMA diblock copolymer to pattern the nanostructure [1-4]. First, a 0.4 weight % solution of PS-*r*-PMMA random copolymer in toluene was spin coated on GaN/Sapphire substrate, where the thickness was about 8 nm. Then these films were cured in UV (254 nm) under vacuum. Thin films of PS-*b*-PMMA diblock copolymer (M_n = 76,000 g/mol and PDI = 1.07), ~ 30 nm (L_o) in thickness, were prepared on these substrates. Films were annealed for 12 hours under vacuum at 170 ^{o}C. Finally, the thin films were exposed to deep-UV radiation to degrade the PMMA, generating the nanoporous template. Figure 1 describes the procedure to make nanoporous template using PS-*b*-PMMA block copolymers. Figure 2 shows the SEM images of nanoporous templates after UV exposure. The detailed technique and results after dry-etching will be presented.

References

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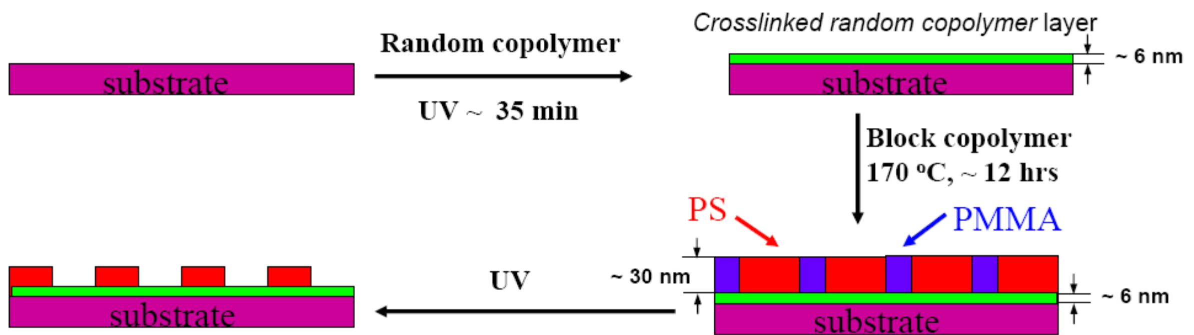

Figure 1. Schematic illustration of fabrication procedure to antireflective nanoporous GaN template.

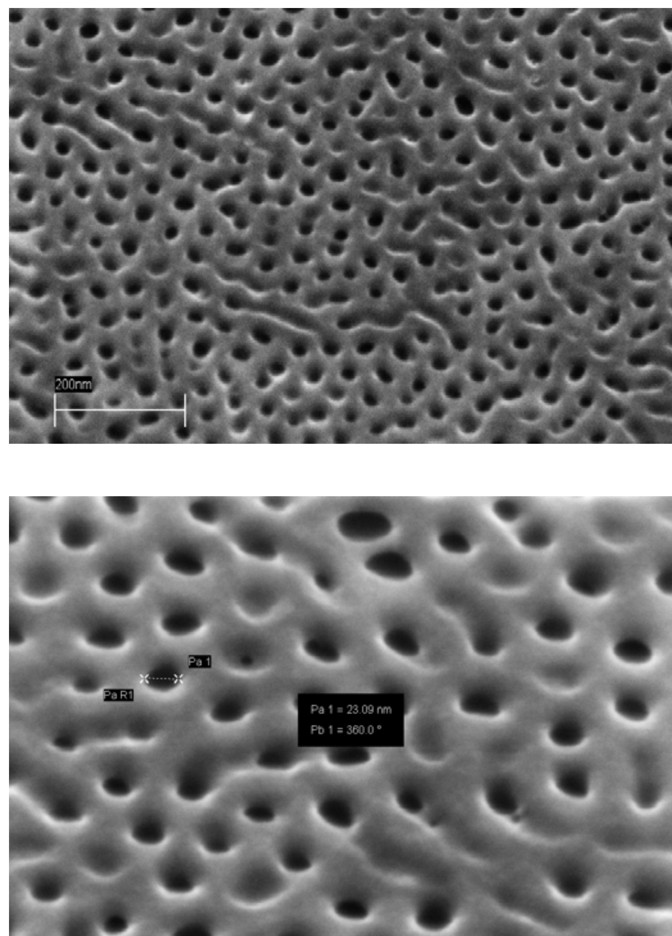

Figure 2. SEM pictures of nanoporous template of GaN substrate after UV exposure.