Fabrication of GaN Porous Structures Using Photo-Electrochemical Etching and Electrode Response

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High-density nanostructures of GaN have been widely investigated for highly-electrochemical responses in chemical sensors, photoelectrodes and so on. Porous structure is one of the attractive nanostructures with the merit of high productivity over a large area and low damages during etching. In this study, the fabrication of porous structures by the electrochemical etching is reported and the electrochemical response of porous electrodes is measured as well.

Two types of n-type GaN epitaxial layers grown on sapphire substrates were used as samples in the experiment with the different doping density $N_D \approx 5 \times 10^{16}$ cm^{-3} and 1×10^{19} cm^{-3}. Photo-electrochemical (PEC) etching under UV was conducted for the porous formation in the electrolyte which was a mixture of 1M H_2SO_4 and 1M H_3PO_4 [1]. The experiment setup is shown in Fig.1. From SEM images shown in Figs. 2(a) and (b), it was found that the diameter of pore is related to doping density. The sample with high doping density ($N_D \approx 1\times 10^{19}$ cm^{-3}) reached the average pore diameter of approximately 55nm. The sample with low doping density ($N_D \approx 5\times 10^{16}$ cm^{-3}) got the large and small pores randomly. The large pores had the average diameter of 70nm but the small pores had the diameter of 37nm, one half of the big poles, approximately. Figure 3 shows the comparison of photocurrent under different wavelength of GaN planar substrate and porous substrate formed at different anodization time. It can be seen that porous structure will gain large photocurrent than planar one, obviously. The details about the correlation between the structural features and the photocurrent response will be reported on the day.

[1] Y. Kumazaki et al., J. Electrochem. Soc. **161** (2014) H705.

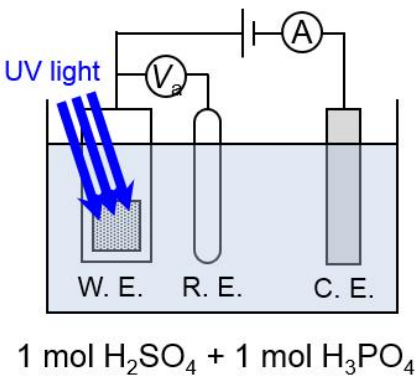

Figure 1: Porous structure fabrication experiment setup

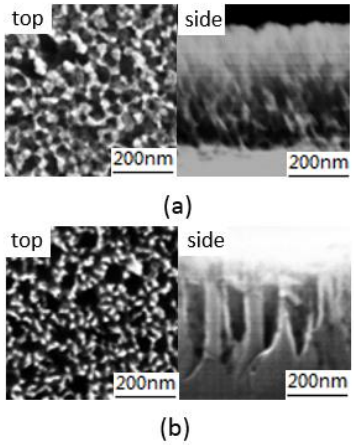

Figure 2: Porous structure SEM image for (a) $N_D \approx 1\times 10^{19}$ cm^{-3} (b) $N_D \approx 5 \times 10^{16}$ cm^{-3}

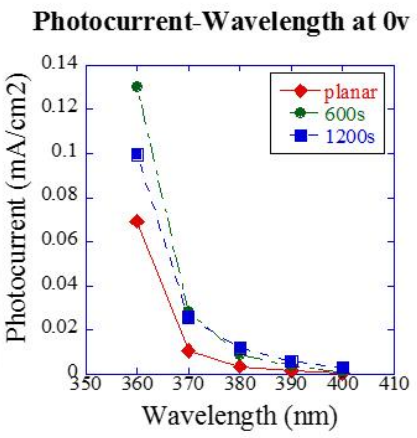

Figure 3: Photocurrent-wavelength curve comparison of different etching time (sample doping density $N_D \approx 1\times 10^{19}$ cm^{-3})