Enhancement of p-GaN conductivity using PECVD SiOx

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A technique to enhance the hole concentration in activated Mg-doped p-type GaN epitaxial layers is described. The method consists of depositing a porous plasma-enhanced chemical vapor deposited SiO$_x$ layer on top of p-GaN after which the sample is heated to 950°C in nitrogen ambient for 1 min followed by the removal of the SiO$_x$ layer in a buffered HF solution. A significant improvement of the conductivity of the p-GaN layer has been obtained.

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intermixing: the more porous the SiO$_x$ layer, the higher the intermixing effect. The quality of the PECVD SiO$_x$ used has been tested, and it is found that a BHF solution removes the SiO$_x$ layer in a few seconds. This reveals that the SiO$_x$ layer used in our special treatment is rather porous and hence is capable of adsorbing the Ga atoms from the top p-GaN layer resulting in the improvement of the conductivity.

From the literature we trace one patent describing the use of a similar technique on p-GaN in order to avoid nitrogen out-diffusion. However the samples with and without a SiO$_x$ layer lead to the same hole concentrations of about $2 \times 10^{17}$ cm$^{-3}$ and hence the SiO$_x$ layer did not improve the conductivity of the p-GaN layer. This would suggest that the SiO$_x$ layer used in that work was not sufficiently porous to introduce Ga vacancies.

Conclusions

We have demonstrated a significant improvement of the conductivity of MOVPE-grown p-GaN epilayers by applying a SiO$_x$ layer followed by an RTA step at 950°C for 1 min in nitrogen ambient. This postgrowth technique can be easily performed to p-GaN layers for improving the conductivity of p-GaN layers, and hence it is very important for the advancement of GaN-based LEDs and lasers.

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References