Direct growth of graphene layers via PECVD on p-$Al_xGa_{1-x}N$ UV-LEDs for p-contact engineering

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$Al_xGa_{1-x}N$ based UV-LEDs are widely considered as a replacement for mercury-based UV-bulbs. An obstacle to wider application of these LEDs is their low efficiency. Among other methods for improving the efficiency, adding a transparent current spreading layer (TCSL) on the p-$Al_xGa_{1-x}N$ side of an LED in standard geometry is a very attractive measure [1]. However, the traditionally used ITO as a TCSL is not suited due to its poor transparency in the UV range [2]. Due to the high electrical conductivity and the high transparency of graphene over the full-spectrum [2], it can serve as a good candidate for the TCSL [3].

In this work, we present the successful direct growth of a thin graphene layer on a p-$Al_xGa_{1-x}N$ layer using a plasma-enhanced (PE) CVD process at low temperatures of around 670°C. Fig. 1a shows an example of a Raman spectrum with ratios of $I_D/I_G \approx 2.1$ and of $I_{2D}/I_G \approx 1.3$, indicating good-quality graphene. The resulting sheet resistance is in the order of 5 kΩ/sq. Additionally, the as-grown graphene layer exhibits an optical transparency of more than 90% from 280 nm to 800 nm (Fig. 1b). Finally, we successfully produced a graphene enhanced $Al_xGa_{1-x}N$ LED in standard geometry, where the graphene acts as TCSL. The resulting current density vs. voltage characteristic shows a diode-like behaviour with a current density of 10^1 A/cm^2 at 5.7 V (Fig. 1c).

References

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[3] J. Mischke et al., 2D Materials 7 (2020) 035019

Figures

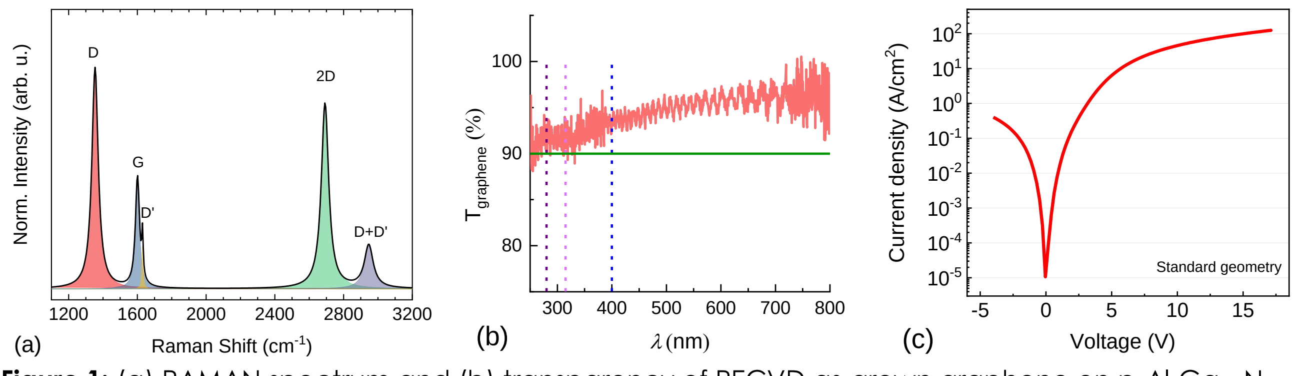

Figure 1: (a) RAMAN spectrum and (b) transparency of PECVD as-grown graphene on p-$Al_xGa_{1-x}N$. (c) Current density vs. voltage of a graphene enhanced UV LED in standard geometry.

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