In-situ Nitrogen-doping of Transfer-free Graphene Wafers for III-Nitride Based Light-Emitting Diodes

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Abstract
The main body could consist of a couple of paragraphs. GaN-Based LEDs, lauded for low-voltage operation, eco-friendliness, and long lifespan, hold great promise in display and optical communication. Presently, GaN thin films are mainly grown on dielectric substrates via MOCVD. However, the inherent lattice and thermal disparities between conventional dielectric substrates and GaN compromise device performance. Graphene, an ideal nitride epitaxy buffer layer, is limited by its chemical inertness. To overcome this challenge, a method has been developed for direct growth of high-quality, mirror-like GaN films on graphene substrates. By employing in-situ and plasma post-treatment nitrogen doping, graphene is selectively modified, enhancing its reactivity through the introduction of active sites. This innovative substrate seamlessly integrates with industrial production processes, facilitating the successful illumination of commercial LED chips. These chips achieve a remarkable 75% illumination yield and a 25% reduction in junction temperature. This work is poised to advance the practical application of graphene-dielectric substrates in LED development, supporting advancements in deep ultraviolet light-emitting devices within the third-generation semiconductor industry.

Figures

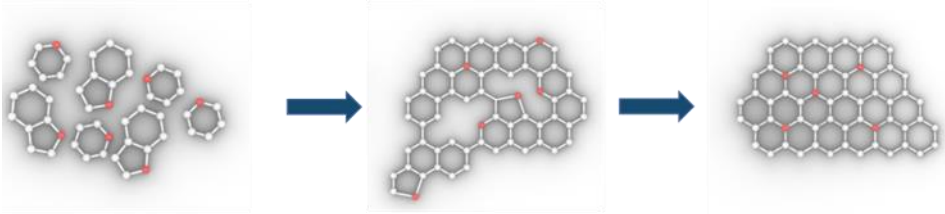

Figure 1: Evolution of nitrogen doping types during graphene growth process

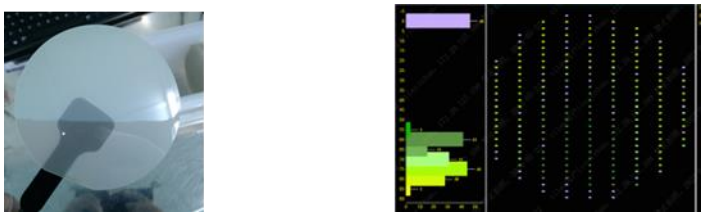

Figure 2: GaN epitaxy on 4-inch graphene wafer and illumination rate of graphene-based LED