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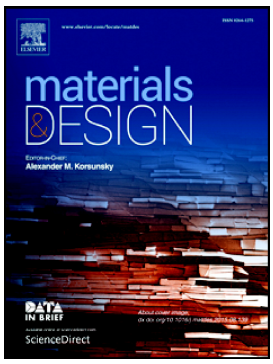

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Performance improvements in AlGaN-based ultraviolet light-emitting diodes due to electrical doping effects

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Abstract

We report a new doping method for the fabrication of wide-bandgap (WB) semiconductors such as p-AlGaN using electric fields and the application of this method to AlGaN-based UV light-emitting diodes (LEDs) to evaluate its effect at the device level. We prepared four LED samples with different work function (WF) energies using Pt, Ni, Ti, or Mg as contact metals and applied electric fields between these metals and the *p*-AlGaN surface across indium-doped tin oxide (ITO)/AlN thin films to facilitate diffusion of the metal atoms into the *p*-AlGaN layer. Compared to the samples with reference ITO electrodes (10 or 100 nm), ohmic behavior on the *p*-AlGaN surface was improved in the samples doped with Pt, Ni (high WF), and Mg (low WF but shallow dopant), but not for the sample doped with Ti (low WF). Furthermore, Mg-doped samples exhibited the lowest contact resistance with reasonably high transmittance among the four samples; accordingly, the lowest forward voltage and highest light-output power were achieved with UV LEDs using ITO/AlN/Mg electrodes. This electrical doping method could be useful for WB semiconductors fabricated with materials such as *p*-AlGaN and *p*-ZnO, which are difficult to dope using either thermal or optical doping method.

Keywords: ultraviolet, transparent conductive electrodes, conducting filaments, electrical breakdown method, light-emitting diodes

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