Dramatically improved current spreading in UV LEDs via Si delta-doping in the n-AlGaN cladding layer

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The poor ionization efficiency of Mg-acceptors in p-AlGaN is widely considered one of the chief obstacles to high-brightness UV LEDs. High contact resistance, joule heating, and poor radiative recombination are attributed to low hole densities in the p-cladding region of UV LEDs. Though Si-donor ionization efficiency is about 2 orders of magnitude higher than that Mg-acceptors, serious complications still remain. The n-cladding sheet resistance in UV LEDs can be as high as 500 ohms/square under optimal Si-doping conditions (n @ 1x1018/cm3). This can affect current spreading to such a degree that UV light generation is observed solely along edges of the p-metal contact, due to current crowding. In an effort to decrease sheet resistance, increasing the doping or thickness of the n-cladding region only increases the likelihood of perilous cracking. We have experimentally found that delta-doping the n-AlGaN cladding region in UV LEDs with 200 Å-thick sheets of 1x1013/cm2 Si-doping can dramatically reduce the sheet resistance (to as low as 30 ohms/square) and thus provide uniform current spreading in high-Al UV LEDs. Furthermore, this allows the n-cladding region to be grown much thinner for reduced cracking.