Review on UV-LEDs: State of the Art and Challenges Ahead

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The latest challenge of LEDs is to residing themselves in advanced ultra-violet (UV) lighting, which involves industrial UV curing (e. coatings, resins, adhesives), medical and scientific (e.g. phototherapy, DNA sensing), sterilization (bacterial disinfection, water purification, skin therapy), security (counterfeit detection and forensics) and horticulture lighting. New market research by *Markets and Markets* reports that the UV LED market is expected to reach USD 369.58 million by 2020. So far, high energy $Al_xGa_{1-x}N$ materials are the best solution to product UV emission LEDs in the wavelength range below 390 nm. Progress on $Al_xGa1_{-x}N$ based UV LEDs is on-going with external quantum efficiency (EQE) above than 10% at present. However, the EQE of most of the UV-B (320-280 nm) and UV-C (280-210 nm) LEDs are still in single-digit percentage range and unable to cope with the current deep UV lighting market demand. The output power of such LEDs is few mWs while limited lifetime is less than a thousand hours. From fundamental point of view, producing UV-LEDs below 360 nm requires more Al composition in the $Al_xGa_{1-x}N$ based active region and high growth temperature above 1100°C. Unfortunately, incorporation of Al atoms into the $Al_xGa_{1-x}N$ lattice structure is not an easy process as the atoms readily react with oxygen, while parasitic reaction becomes much more serious at high temperature. These effects significantly kill the overall efficiency of the LEDs. In this talk, novel published techniques to solve the above problems will be reviewed and near-future work in developing UV-LEDs at INOR, USM will be presented.