Wide Band Gap Semiconductor Technology

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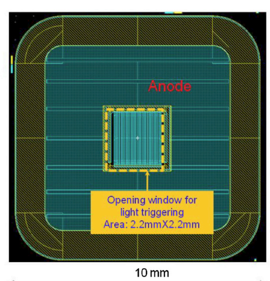
Applications of wide band gap semiconductors, such as *GaN*, *AlGaN*, and *InGaN*, range from lighting to high power, radiation hard, and high temperature electronics. Wurtzite (hexagonal) symmetry makes these materials to be quite different from more conventional semiconductors, such as *Si*. Spontaneous and piezoelectric polarization associated with the wurtzite crystal structure leads to the formation of two-dimensional electron gases at *AlGaN/GaN* and *AlGaN/InGaN* interfaces, with sheet concentrations 10 to 20 times higher than those in *Si* CMOS. A high current carrying capability and a high breakdown field make these materials perfect for high power applications. Adjusting the energy gaps of $Al_xGa_{1-x}N$ and of $In_xGa_{1-x}N$ by varying the molar fraction, x, changes the wavelength of light they emit or absorb. This makes these materials suitable for light emitters, solar cells, and photodetectors operating from infrared to deep ultraviolet range. Blue, green, and white LEDs using *InGaN* revolutionized smart solid-state lighting. *AlGaN* deep UV LEDs are used for water purification, fighting antibiotic resistant bacteria and viruses, and dramatically increasing produce storage time. But wide band gap semiconductor technology has many difficult and exciting problems to solve. High dislocation density in these materials leads to low efficiency of deep *AlGaN* UV LEDs and reliability problems of high power devices. Non-uniformities of the electric field distribution cause a premature breakdown. LED spectral power distributions are poorly described by conventional metrics of color quality and require new designs of lighting appliances. This field is a researcher dream! It is poised for synergy with educational efforts to train a new generation of engineers and scientists capable of solving these problems and using wide band gap semiconductor devices in systems that will make our lives better.

Deep UV LED water disinfection unit (from I. Gaska, O. Bilenko, I. Shturm, S. Smetona, Y. Bilenko, M. Shatalov, T. Bettles, R. Gaska, M. Shur, Z. Gleason, M. Sim, T. Oriard, Deep UV Light Emitting Diode Technology for compact Point-of-Use Water Disinfection Systems, presented at Clean Tech 2013)



1300 A/12 kV *SiC* thyristor (from S L Rumyantsev, M E Levinshtein, M S Shur, T. Saxena, J W Palmour, A K Agarwal, J Jang, High current (100 A) optical triggering of high voltage (12 kV) 4H-SiC thyristor, Semiconductor Sci. Tech. Vol. 27 No 1, 015012 (2012)

Treating affective seasonal disorder using versatile solid state lamp with blue *InGaN* LEDs (from A. Žukauskas, M. S. Shur, and R. Gaska, Introduction to Solid State Lighting, John Wiley and Sons, 2002)