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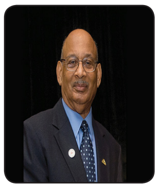
Abstract



Laser direct writing in wide bandgap semiconductors for advanced interconnect and gas sensor applications

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Abstract:

A direct conversion technique is demonstrated to produce highly conductive tracks on silicon carbide by irradiating it with a laser beam. It is found that laser irradiation of insulating silicon carbide substrates decreases its resistivity from 1011 to 10–4 ohm-cm. Laser irradiation of silicon carbide in the presence of pure oxygen produces insulating tracks. Nanosecond pulsed Laser Direct-Write and Doping (LDWD) technique is used to heat an epilayer below its decomposition temperature for in situ fabrication of nanoribbons exhibiting graphene-like crystalline hexagonal structure containing 15-17 individual sheets. The process can be modified to create carbon rich surfaces and embedded carbon regions, particularly graphene, using multiphoton photolytic laser processing on or in silicon. Graphene can also be formed on silicon carbide by the photolytic process provided the silicon carbide structure/chemistry is transparent to the processing laser wavelength. High pressure laser implantation (HPLI), enhances nitrogen dopant solubility in silicon carbide resulting in dopant concentrations greater than 4.8 x 1020 atoms/cc at a depth greater than 1 micron. HPLI has promise for improved doping of gallium nitride substrates with magnesium and the amphoteric dopants carbon and silicon. The LDWD process is expected to revolutionize the future of nanodevice fabrication with nanoscale interconnects for high temperature and high power electronic and optoelectronic applications using SiC. This process is demonstrated to produce doped tracks of lower electrical resistance on polycrystalline and single crystal SiC substrates. The selective-area doping is a mask-free process to produce novel electronic and photonic devices. Using this doping technique, uncooled SiC-based gas sensors are produced and these sensors yield optical signals instead of electrical signals generated by conventional sensors. P-type dopants Ga, Sc, P and Al

are incorporated into an n-type crystalline 6H-SiC substrate by a laser doping technique for sensing CO2, CO, NO2 and NO gases, respectively.

Biography:

Nathaniel R. Quick, PhD is fellow and executive director of the Laser Institute of America (LIA). He is the president and CTO of AppliCote Associates, LLC, Lake Mary, FL., specializing in advanced materials transformation using high pressure laser implantation. He currently holds 62 U.S. patents and has over 60 publications. Dr. Quick has a PhD from Cornell University in Materials Science and Engineering.

Recent Publications:

- Transformation of Gaussian beams into M-beams for advanced microvia drilling January 2017
- Laser doping of GaN for advanced optoelectronic applications January 2014
- Laser Surface Modification of Electronic Properties in Wide Band Gap Materials October 2013
- Laser-Patterned Blue-Green SiC LED January 2011
- Laser optical gas sensor by photoexcitation effect on refractive index March 2010

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