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Properties of hexagonal boron nitride grown on sapphire and silicon substrates for application in deep UV photonics

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Hexagonal boron nitride (hBN) is a wide bandgap semiconductor (Eg~6eV) with sp2-hybridized atomic sheets of boron and nitrogen. This material has attracted much attention for its properties such as high resistivity, high thermal conductivity (2000 Wm-1K-1), and stability in aggressive chemical environments and at high temperatures (up to 1000°C). hBN, an insulating isomorph of graphene, has a small (1.7%) lattice mismatch to graphene and is expected to be atomically smooth and free from dangling bonds because of its sp2-hybridized bonding and weak interplanar Van der Waals bond. Hence, hBN is an excellent candidate to be used as a supporting substrate and gate dielectric for graphene based electronics. hBN is also an emerging material for deep UV photonics and for solid state thermal neutron detector application, since 10B, a constituent element of hBN, has a large thermal neutron capture cross section (3840 barns). This talk will present the recent results on the growth and characterization of thick (>12 μm) hexagonal boron nitride (hBN) and its use for deep UV detection and for solid-state thermal neutron detection. The hBN epilayers were grown by metalorganic chemical vapor deposition on sapphire and silicon substrates at a temperature of 1350°C. A thin and amorphous nitride layer was formed at a low temperature (850°C) on sapphire substrates, which enabled subsequent epitaxial hBN growth at 1350°C. The influences of the sapphire nitridation temperature and the growth temperature on the film quality were analyzed by X-ray diffraction (XRD) measurements and UV response. X-ray diffraction peak from the (002) hBN plane at a 2θ angle of 26.7° exhibited the c-lattice constant of 6.66 Å for these films. A strong peak corresponding to the high frequency Raman active mode of hBN was found for the films at 1370.5 cm^{-1}. X-ray photoelectron spectroscopy analysis confirmed the formation of stoichiometric hBN films with excellent uniformity. On silicon substrate, it was necessary to deposit first a thin film of boron to prevent silicon nitride formation and degradation of the film quality. Thickness up to 15 microns have been grown and characterized. These results will be presented at the talk.

Biography

Ishwara Bhat has received his PhD degree in Electrical Engineering from Rensselaer Polytechnic Institute in 1985 and has joined the Department as a Research Assistant Professor in 1988 and tenure tract Associate Professor in 1991. Since 1999, he has been a Full Professor. His research interests include narrow gap materials such as HgCdTe, InGaSb as well as high band gap materials such as SiC and hBN. He has over 30 years of experience working in II-VI, III-V and IV-IV compounds, and has demonstrated several growth and device innovations. He has published over 150 refereed journal articles and presented in over 100 conferences, both contributed and invited over the last 30 years.

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