Title: Demonstration of thick phase-pure β-Ga_2O_3 on a c-plane sapphire substrate using MOCVD

Abstract: We demonstrated a metal-organic chemical vapor deposition (MOCVD) of smooth, thick, and monoclinic phase-pure gallium oxide (Ga_2O_3) on c-plane sapphire using silicon-oxygen bonding (SiO_x) as a phase stabilizer. The corundum (α), monoclinic (β), and orthorhombic (ε) phases of Ga_2O_3 with a bandgap in the 4.4 – 5.1 eV range, are promising materials for power semiconductor devices and deep ultraviolet (UV) solar-blind photodetectors. The MOCVD systems are extensively used for homoepitaxial growth of β-Ga_2O_3 on (001), (100), (010), and ($\bar{2}01$) β-Ga_2O_3 substrates. These substrates are rare/expensive and have very low thermal conductivity; thus, are not suitable for high-power semiconductor devices. The c-plane sapphire is typically used as a substrate for high-power devices. The β-Ga_2O_3 grows in the ($\bar{2}01$) direction on sapphire. In this direction, the presence of high-density oxygen dangling bonds, frequent stacking faults, twinning, and other phases and planes impede the heteroepitaxy of thick β-Ga_2O_3. Previously phase stabilizations with SiO_x have been reported for tetragonal and monoclinic hafnia. We were able to grow ~580nm thick β-Ga_2O_3 on sapphire by MOCVD at 750 ºC through phase stabilization using silane. The samples grown with silane have a reduction in the surface roughness and resistivity from 10.7 nm to 4.4 nm and from 371.75 Ω.cm to 135.64 Ω.cm, respectively. These samples show a pure-monoclinic phase determined by x-ray diffraction (XRD); have tensile strain determined by Raman strain mapping. These results show that a thick, phase-pure β-Ga_2O_3 can be grown on c-plane sapphire which can be suitable for creating power devices with better thermal management.

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