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Photodetector Based on β-Ga_2O_3 Nanowires on GaS_xSe_{1-x} Solid Solution Substrate

Veaceslav Sprincean, Mihail Caraman, Haoyi Qiu, Tim Tjardts, Alexandr Sereacov, Cenk Aktas, Rainer Adelung, Oleg Lupan

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Abstract

The detection of radiation in the ultraviolet C (UVC) region (100–280 nm) is of great importance for numerous technical applications, such as fire detection in security devices, tracking astronomical missile trajectories, chemical-biological analyses, and medicinal applications. Wide bandgap semiconductors have emerged as ideal materials for electronic devices operating in this spectral range. Among the various promising materials, β-Ga_2O_3, a gallium oxide with a monoclinic crystal lattice, has garnered significant attention along with $Al_xGa_{1-x}N$, AlN, and BN. While thin layers of $Al_xGa_{1-x}N$ suffer from structural instability, AlN exhibits photosensitivity to radiation with wavelengths shorter than 215 nm. On the other hand, cubic BN possesses an absorption band fundamental in the UV-vacuum region ($\lambda \leq 195$ nm). Notably, β-Ga_2O_3, with its direct n-type energy bands and a bandgap of 4.5–4.9 eV, demonstrates high photosensitivity in the UVC range, making it an excellent material for photoreceptors in the 220–280 nm range. In this study, we investigate the elemental chemical composition, absorption band edge, vibrational and photoresponsive properties of β-Ga_2O_3 nano-wire/nano-ribbon assemblies on a substrate of monocrystalline lamellae from GaS_xSe_{1-x} solid solutions ($x = 0.17$). The nano-wire assemblies were grown using thermal oxidation of gallium compound semiconductors at temperatures ranging from 750 to 950 °C in an oxygen or water vapor-enriched atmosphere. Our findings provide valuable insights into the potential of β-Ga_2O_3 nanostructures as efficient photoreceptors for UVC radiation detection.

Keywords: ultraviolet radiation, wide bandgap semiconductors, nano-wires, photoreceptors, thermal oxidation, photodetection

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