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Structural, optical and photoresponse characteristics of metal-insulator-semiconductor (MIS) type Au/Ni/CeO_2/GaN Schottky barrier ultraviolet photodetector

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Abstract

GaN based metal-insulator-semiconductor (MIS) type ultraviolet photodetector was fabricated and investigated using high-k dielectric CeO_2 as an insulating oxide layer. Using XRD analysis, the phase formation of the as-deposited CeO_2 films on GaN was found to be cubic fluorite. Non-contact mode atomic force microscopy technique was utilized and explored the surface morphology of CeO_2 films on GaN composed of prearranged clusters of spherical shape with an average rms surface roughness of 0.428 μm. XPS analysis has revealed the existence of two oxidation states such as Ce^{3+} and Ce^{4+} in the Ce3d spectral envelop. Using absorbance versus wavelength data, the Tauc's plot was plotted and calculated a direct optical bandgap of 3.52 eV. The current-voltage (I–V) characteristics extracted from the device revealed the symmetric behavior or formation of back-to-back Schottky barrier at the metal-semiconductor (MS) interface. Photoresponsivity of the device at +10 V bias was calculated as 28.99 A/W and it is higher compared to the values extracted from metal-semiconductor-metal (MSM) type UV PDs reported in the literature. Furthermore, the transient response characteristics of the prepared device showed good stability with almost same rise time and fall time of ~2.73 s and ~5.35 s, respectively. Based on the device performance, the proposed MIS type structure could be a suitable for the development of ultraviolet photodetectors.

Keywords:

NHEP-CAT redox system, Oxidation-kinetics, Rate law, Mechanism, Activation parameters

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