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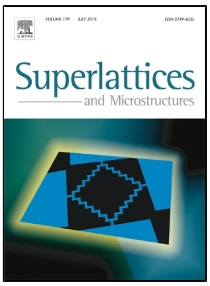

Investigation of barrier inhomogeneities in *I-V* and *C-V* characteristics of Ni/*n*-TiO_2/*p*-Si/Al heterostructure in wide temperature range

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Investigation of barrier inhomogeneities in *I-V* and *C-V* characteristics of Ni/*n*-TiO_2/*p*-Si/Al heterostructure in wide temperature range

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Abstract

In this study, we report on the growth and electrical characterization of Ni/*n*-TiO_2/*p*-Si/Al heterojunction. A thin layer of TiO_2 was deposited on *p*-Si by pulsed layer deposition technique. Highly pure nickel and aluminum metals were deposited by thermal coating system to make the contacts to *n*-TiO_2 and *p*-Si, respectively. The pulsed laser ablation processed Ni/*n*-TiO_2/*p*-Si/Al heterojunction exhibits good rectifying properties over the wide range of temperature between 80 K to 300 K. The X-ray diffraction (XRD) investigations have confirmed the epitaxial growth of the TiO_2 films which are highly oriented nanocrystals with particle size of 43.3 nm. The optical energy band gap of TiO_2 thin films was studied using *UV-VIS* spectroscopy and Tauc plots, which comes out to be 3.20 eV. Atomic force microscopy study of the surface morphology reveals that the surface is reasonably smooth, homogeneous and the roughness is of nanometer order. The dominating current transport mechanisms through the heterojunction were investigated in forward and reverse bias current-voltage (*I-V*) measurements. The current transport mechanisms are strong functions of temperature and successfully explained using thermionic emission diffusion (TED) mechanism with Gaussian distributions of barrier heights. The dependence of barrier height on temperature and the non-linearity of activation energy plot have confirmed that barrier heights at *n*-TiO_2/*p*-Si interface follow the Gaussian distributions. The mean value of barrier height and standard deviation were found to be 0.79 eV and 0.10 V, respectively. The effective resistance of the heterojunction plays an important role in the *I-V* characteristics as well as in rectifying properties. The barrier heights as a function of temperature were also studied from reverse biased capacitance-voltage (*C-V*) characteristics. The discrepancy between the barrier heights calculated from *I-V* and *C-V* measurements has been attributed to the existence of barrier inhomogeneities and tunneling factor in the current transport mechanisms. The value of Richardson's constant found to be 1.5×10^5 $Am^{-2}K^{-2}$ which is of the order of known theoretical value of 3.2×10^5 Am^{-2} K^{-2}.

Keywords: *I-V* characteristics, *C-V* characteristics, Heterojunctions, Gaussian distributions, *UV -VIS* spectroscopy.

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Introduction

Titanium dioxide (TiO_2) is a non-toxic *n*-type wide band gap semiconductor material with low production cost and high-temperature stability. TiO_2 crystallizes in three polymorphs namely rutile, anatase and brookite.