Seminar

Institute for Plasma Research

Title : UV-VISIBLE Photodetection Properties of Pulsed Laser Deposited TiO_2 and Nb:TiO_2 Thin Films Grown on Si Substrate

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Venue : Online - Join the talk: https://meet.ipr.res.in/Dr.AvijitDewasi_PDFTalk

Abstract :

The UV-Visible photoresponse of anatase TiO_2 and Nb-doped TiO_2 (Nb:TiO_2) thin film grown on *p*-type Si substrates (*p*-Si) will be presented systematically. TiO_2 thin film of different thicknesses (39-201 nm) were grown on pristine *p*-Si substrates to explore the influence of the TiO_2 film thickness on the antireflection, and photodetection properties of the *n*-TiO_2/*p*-Si heterojunction structure. The photoresponsivity of the *n*-TiO_2/*p*-Si heterostructure under ultraviolet (UV) and AM 1.5G solar simulated light was found to decrease with an increment of the thickness of the TiO_2 layer. TiO_2(55 nm)/*p*-Si heterostructure exhibited the best photoresponse under the illumination of both UV and solar irradiance with responsivity ~0.14 A/W and ~0.09 A/W at -5V bias, respectively.

To improve the photoresponse of the optimized *n*-TiO_2 (55 nm)/*p*-Si heterojunction diode, TiO_2 layer (55 nm) was deposited on the chemically etched pyramidal textured *p*-Si substrate. After tuning the chemical etching parameters, the minimum total reflectance of ~7.6% was achieved for textured-Si substrate in the wavelength range of 300-900 nm. The reflectance further dropped down to 6.5% when the TiO_2 layer was deposited on the top surface of the textured Si substrate. TiO_2 (55 nm)/Textured-Si heterostructure exhibited a better response under the illumination of both UV and solar irradiance with responsivity ~0.22 A/W and ~0.13 A/W at -2V bias, respectively. One of the reasons for lower photoresponse was the high resistivity of TiO_2. To improve the conductivity, Nb doping was introduced in the TiO_2 thin film and deposited on *p*-Si substrates. A comparative study on the UV-Visible light detection properties of the optimized Nb:TiO_2 thin films for two different concentrations of Nb doping (3.1 and 4.2 at.%) with the undoped TiO_2 was explored further. Under illuminated condition, *n*-Nb:TiO_2/*p*-Si heterojunction with Nb doping concentration (4.2 at.%) in Nb:TiO_2 film showed better photoresponse with responsivity value (at -3V bias) 1.09 A/W and 1.60 A/W under solar simulated light and UV light, respectively. Moreover, the heterojunction photodiode exhibited fast photoresponse to both UV (rise time ~28 ms and fall time ~30 ms) and solar simulated light (rise time ~26 ms and fall time ~29 ms). The above findings enhanced our understanding about the fabrication of high-speed optoelectronic devices based on reverse-biased *n*-Nb:TiO_2/*p*-Si heterojunctions.