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Title : FABRICATION AND CHARACTERIZATION OF TITANIUM DIOXIDE NANOROD ARRAYS-BASED ULTRAVIOLET PHOTOSENSOR USING A NOVEL FACILE METHOD

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In this research, self-powered ultraviolet (UV) photosensor has been successfully fabricated using titanium dioxide nanorod arrays (TNAs). Our study has introduced a novel one-step sol-gel immersion method to synthesize and deposit thin film TNAs on a substrate at low deposition time (≤ 5 hours) and growth temperature (≤ 150 °C) in a facile glass container. Particularly in this work, TNAs were grown in a Schott bottle to replace the use of stainless steel-based autoclave, which has been commonly employed for the growth of TiO2 nanoparticles, even at low temperature. The utilization of glass container has expedited and opened up opportunities for extensive research and development on facile and rapid growth of TNAs in various applications. The main purpose of this thesis is to effectively tune the TNAs for its specific application in PEC-based UV photosensor by several processing parameters such as deposition time, growth temperature, and molar concentration of titanium precursor. Effect of aluminium (Al) dopant on the TNAs was also investigated to further enhance the performance of the fabricated UV photosensor. The synthesized and deposited TNAs were characterized for its structural, optical and electrical properties in detail via field emission scanning electron microscopy X-ray diffraction, atomic force microscopy, energy dispersive X-ray spectroscopy, Raman spectroscopy, ultraviolet-visible-infrared spectrophotometry and two-probe current-voltage measurement system. The fabricated PEC-based UV photosensor was analysed via two-terminal probe photocurrent measurement unit under UV lamp (365 nm, 750 μW/cm2) and electrochemical impedance spectroscopy for impedance analysis. The self-powered UV photosensor with TNAs immersed for 3 hours, 150 °C and 0.07 M concentration of titanium precursor (tetrabutyl titanate) showed the best performance of photocurrent at 0 V bias of 26.31 μA, and responsivity of 0.035 A/W, with extremely small and negligible response and recovery times. The optimum performance was due to high surface over volume ratio, high photocurrent gain and low recombination of the excitonic charge carriers. The minimum temperature required for the growth of TNAs through our introduced method was 115°C, with the smaller ever recorded diameter size and length of the nanorod at 33 nm and 0.27 μm, respectively. In addition, the performance of the fabricated UV sensor could be further enhanced through the doping of 2 at. % of aluminium content, with the measured photocurrent and responsivity at 108.87 and 0.145 A/W, respectively. Another alternative structure besides PEC has been conducted using n-type TNAs and p-type nickel oxide (NiO) nanosheets (NNS) heterojunction-based self-powered UV photosensor. A maximum photocurrent of 0.510 μA was achieved under the same UV irradiation. This optimization process not only delivers the effective way to fabricate the self-powered UV photosensor device in particular, but also offers some expedient results with respect to its properties, which leads to the basis of theoretical and experimental for better understanding of fundamental physics and extensive applications of TiO2 related structures.