World Academy of Science, Engineering and Technology
International Journal of Materials and Metallurgical Engineering
Vol:18, No:07, 2024

Enhanced Photoelectrochemical performance of TiO_2 Nanorods: The Critical Role of Hydrothermal Reaction Time

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Abstract : The synthesis of titanium dioxide (TiO_2) nanorods (NRs) on fluorine-doped tin oxide (FTO) glass via hydrothermal methods was investigated to determine the optimal reaction time for enhanced photocatalytic and optical performance. Reaction times of 4, 6, and 8 hours were studied. Characterization through SEM, UV-vis, XRD, FTIR, Raman spectroscopy and photoelectrochemical (PEC) techniques revealed significant differences in the properties of the TiO_2 NRs based on the reaction duration. XRD and Raman spectroscopy analysis confirmed the formation of the rutile phase of TiO_2. As photoanodes in PEC cells, TiO_2 NRs synthesized for 4 hours exhibited the best photocatalytic activity, with the highest photocurrent density and superior charge transport properties, attributed to their densely packed vertical structure. Longer reaction times resulted in less optimal morphological and photoelectrochemical characteristics. The bandgap of the TiO_2 NRs remained consistent around 3.06 eV, with only slight variations observed. This study highlights the critical role of reaction time in hydrothermal synthesis, identifying 4 hours as the optimal duration for producing TiO_2 NRs with superior photoelectrochemical performance. These findings provide valuable insights for optimizing TiO_2-based materials for solar energy conversion and renewable energy applications.

Keywords : titanium dioxide, nanorods, hydrothermal, photocatalytic, photoelectrochemical
Conference Title : ICMSE 2024 : International Conference on Materials Science and Engineering
Conference Location : Tokyo, Japan
Conference Dates : July 22-23, 2024