DESAIN MATERIAL FOTOKATALIS TITANIUM DIOKSIDA TERDOPING NITROGEN BERBENTUK NANOWIRE UNTUK PRODUKSI BAHAN BAKAR HIDROGEN YANG LEBIH EFEKTIF

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ABSTRACT

DESIGN OF NITROGEN-DOPED TITANIUM DIOXIDE NANOWIRE PHOTOCATALYST FOR MORE EFFICIENT HYDROGEN FUEL PRODUCTION

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Alternative and environmentally friendly energy has become a global necessity amid rapid economic development and population growth. Hydrogen (H_2) is known as an alternative energy source with zero carbon emissions and can be produced through the photocatalytic method using TiO_2. Based on the potential demand for hydrogen, this study aims to synthesize and optimize nitrogen-doped TiO_2 using amonium nitrate as the nitrogen source for photocatalytic hydrogen (H_2) production. The synthesis was carried out in situ from a Ti foil substrate using the hydrothermal method. N-doped TiO_2 nanowire films were successfully synthesized with variations in the mass of amonium nitrate. The added masses of amonium nitrate were 1.2 g (ANT-1), 2.4 g (ANT-2), and 3.6 g (ANT-3). Meanwhile, TiO_2 without the addition of nitrogen dopant was used as a control (TN). The characteristics of all samples were observed using X-Ray Diffraction (XRD), Raman Spectroscopy, Fourier Transform Infra-Red (FTIR), Scanning Electron Microscopy-Energy Dispersive X-Ray (SEM-EDX), Diffuse Reflectance Spectroscopy Ultra Violet-Visible (DRS UV-Vis), Electrochemical Impedance Spectroscopy (EIS), and X-Ray Photoelectron Spectroscopy (XPS). XRD analysis showed that the synthesized TiO_2 crystal has an anatase phase with a peak at $2\theta = 25.13$, supported by Raman spectroscopy results. FTIR analysis showed the presence of Ti-O-Ti bond vibrations at a wavenumber around 500 cm^{-1}, indicating the successful formation of TiO_2 photocatalyst. Surface morphology and elemental composition from SEM-EDX characterization showed that ANT-1 has a one-dimensional wire (1D Nanowires) morphology with the smallest average nanowire diameter compared to other samples, and nitrogen (N) elements were detected in all ANT sample variations. DRS UV-Vis results showed that ANT-1 had a band gap of 2.97 eV, which is lower than other concentration variants. The smallest Nyquist radius in ANT-1 indicated good charge separation efficiency and electron transfer. XPS confirmed the presence of nitrogen dopant through the N 1s peak at 399.6 eV. The photocatalytic activity for hydrogen production was tested on the N-doped TiO_2 photocatalyst for 180 minutes. Based on the hydrogen production test results, ANT-1 produced the highest amount of hydrogen among all samples, at 130.31 µmol/g. ANT-1 was able to produce hydrogen 2.2 times more than the nitrogen-free sample (TN). From this study, it can be concluded that the N-doped TiO_2 nanowire with the highest photocatalytic hydrogen gas production activity is the ANT-1 sample.

Keywords: N-Doped TiO_2; Hydrogen Production; Photocatalytic; Amonium Nitrate; Nanowires.