

**SINTESIS Mn, N-BIDOPED TiO<sub>2</sub>/ZrO<sub>2</sub> SEBAGAI FOTOKATALIS  
RESPONSIF SINAR TAMPAK PADA FOTODEGRADASI  
METILEN BIRU**

Fatkhurizkia Annisafitri  
18/427617/PA/18577

**INTISARI**

Sintesis Mn, N-*bidoped* TiO<sub>2</sub>/ZrO<sub>2</sub> sebagai fotokatalis responsif sinar tampak pada fotodegradasi metilen biru telah dilakukan. Pengaruh konsentrasi dopan mangan dan suhu kalsinasi terhadap karakter kristal dan aktivitas fotokatalitik material Mn, N-*bidoped* TiO<sub>2</sub>/ZrO<sub>2</sub> dipelajari pada penelitian ini. Proses sintesis dilakukan dengan menggunakan metode sol-gel dan diawali dengan membuat prekursor TiO<sub>2</sub> dari TTIP dan etanol, kemudian direaksikan dengan ZrO<sub>2</sub>, urea, dan dopan MnCl<sub>2</sub>·4H<sub>2</sub>O dengan variasi konsentrasi 2, 4, 6, 8, dan 10 % (b/b). Material hasil sintesis dikalsinasi dengan suhu 500, 700, dan 900 °C dan dikarakterisasi menggunakan instrumen *Fourier Transform Infrared Spectrophotometer* (FT-IR), *Specular Reflectance UV-Visible Spectrophotometer* (SR-UV), *X-Ray Diffractometer* (XRD), dan *Scanning Electron Microscope - Energy Dispersive X-Ray* (SEM-EDX). Uji fotokatalitik dilakukan pada larutan metilen biru selama 15, 30, 45, 60, 75, 90, 105, dan 120 menit.

Hasil penelitian menunjukkan bahwa penambahan dopan Mn dan N menggeser tepi serapan fotokatalis ke daerah sinar tampak, dan menurunkan nilai energi celah pita dari material sampai pada kondisi optimum. Semakin tinggi suhu kalsinasi, terjadi peningkatan ukuran kristal, pengurangan kandungan OH, dan perubahan fasa kristal TiO<sub>2</sub> dari anatase menjadi rutil. Nilai energi celah pita pada kondisi optimum diperoleh 2,70 eV ketika dilakukan penambahan dopan Mn 6 % (b/b). Aktivitas fotokatalitik akan meningkat seiring dengan kenaikan penambahan dopan Mn sampai pada kondisi optimum. Pada kondisi optimum, material 6 % Mn, N-*bidoped* TiO<sub>2</sub>/ZrO<sub>2</sub> 500 °C dapat mendegradasi 69,92 % larutan metilen biru 4 ppm selama 120 menit dengan nilai  $k_{obs}$  sebesar  $0,992 \times 10^{-2}$  ppm/menit.

Kata kunci: fotodegradasi, metilen biru, titanium dioksida, zirkonium dioksida

***SYNTHESIS OF Mn, N-BIDOPED TiO<sub>2</sub>/ZrO<sub>2</sub> AS VISIBLE-LIGHT RESPONSIVE PHOTOCATALYST IN METHYLENE BLUE PHOTODEGRADATION***

Fatkhurizkia Annisafitri  
18/427617/PA/18577

**ABSTRACT**

The synthesis of Mn, N-bidoped TiO<sub>2</sub>/ZrO<sub>2</sub> as a visible-light-responsive photocatalyst for the photodegradation of methylene blue has been conducted. This study investigates the influence of manganese dopant concentration and calcination temperature on the crystal characteristics and photocatalytic activity of Mn, N- bidoped TiO<sub>2</sub>/ZrO<sub>2</sub> materials. The synthesis process was carried out using the sol-gel method, starting with the preparation of the TiO<sub>2</sub> precursor from TTIP and ethanol, which was subsequently reacted with ZrO<sub>2</sub>, urea, and the dopant MnCl<sub>2</sub>·4H<sub>2</sub>O at different concentrations of 2, 4, 6, 8, and 10 % (w/w). The synthesized materials were calcined at temperatures of 500, 700, and 900 °C and characterized using using Fourier Transform Infrared Spectrophotometer (FT-IR), Specular Reflectance UV-Visible Spectrophotometer (SR-UV), X-Ray Diffractometer (XRD), and Scanning Electron Microscope-Energy Dispersive X-Ray (SEM-EDX). The photocatalyst was contacted with a methylene blue solution for 15, 30, 45, 60, 75, 90, 105, and 120 minutes.

The results showed that the addition of Mn and N dopants shifts the absorption edge of the photocatalyst to the visible light region and reduces the bandgap energy of the material to an optimal level. Higher calcination temperatures increase crystal size, reduce OH content, and cause a phase transition in TiO<sub>2</sub> from anatase to rutile. The optimal bandgap energy value obtained was 2.70 eV with the addition of 6 % Mn (w/w). Photocatalytic activity increases with higher Mn dopant concentrations up to the optimal condition. Under optimal conditions, the 6 % Mn, N- bidoped TiO<sub>2</sub>/ZrO<sub>2</sub> material calcined at 500 °C was able to degrade 69.92 % of a 4 ppm methylene blue solution within 120 minutes, with a  $k_{obs}$  value of  $0.992 \times 10^{-2}$  ppm/min.

**Keywords:** methylene blue, photodegradation, titanium dioxide, zirconium dioxide