

**FOTODEGRADASI FENOL DI BAWAH IRADIASI SINAR TAMPAK  
MENGGUNAKAN KOMPOSIT Cu-N-CODOPED ZrTiO<sub>4</sub>  
SEBAGAI FOTOKATALIS BERKINERJA TINGGI**

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**INTISARI**

Fotodegradasi fenol di bawah iradiasi sinar tampak menggunakan komposit zirkonium titanat terdoping tembaga-nitrogen (Cu-N-*codoped* ZrTiO<sub>4</sub>) telah dilakukan. Penelitian ini bertujuan untuk mempelajari pengaruh variasi konsentrasi doping logam Cu dan temperatur kalsinasi 500, 700 dan 900 °C terhadap karakteristik Cu-N-*codoped* ZrTiO<sub>4</sub> untuk mendegradasi larutan fenol di bawah iradiasi sinar tampak.

Material fotokatalis disintesis melalui metode sol-gel yang diawali dengan melarutkan TTIP ke dalam etanol. Suspensi zirkonia yang mengandung 10% nitrogen (N) dan tembaga (Cu) dengan variasi konsentrasi 1,0; 3,0; 5,0; 7,0 dan 9,0% dicampurkan ke dalam larutan TTIP. Campuran suspensi tersebut disentrifugasi dan diambil endapannya untuk dikeringkan. Padatan yang telah kering dikalsinasi pada temperatur 500, 700 dan 900 °C. Komposit dikarakterisasi menggunakan FTIR, XRD, SEM-EDX, dan SR-UV. Fotodegradasi larutan fenol 10 ppm dilakukan pada variasi waktu iradiasi 15, 30, 45, 60, 75, 90, 105 dan 120 menit di bawah sinar tampak. Konsentrasi fenol setelah fotodegradasi diukur menggunakan spektrofotometer UV-Vis pada panjang gelombang 268 nm.

Hasil menunjukkan spektra FTIR komposit Cu-N-*codoped* ZrTiO<sub>4</sub> terdapat *overlapping* antara vibrasi Zr–O dan Ti–O–Ti pada bilangan gelombang 500-650 cm<sup>-1</sup>. Analisis difraktogram komposit tersebut mengindikasikan terbentuknya struktur kristal rutil pada temperatur 700 dan 900 °C, sedangkan pada temperatur 500 °C merupakan kristal anatas. Morfologi permukaan komposit Cu-N-*codoped* ZrTiO<sub>4</sub> berbentuk bulat, kasar dan homogen berdasarkan pengamatan dari hasil citra SEM. Analisis EDX membuktikan keberadaan unsur utama Zr, O, Ti, Cu dan N pada material yang disintesis. Analisis tepi serapan spektra SR-UV memberikan energi celah pita sebesar 2,61 eV, sehingga tepi serapan komposit Cu-N-*codoped* ZrTiO<sub>4</sub> aktif di daerah serapan sinar tampak. Komposit Cu-N-*codoped* ZrTiO<sub>4</sub> pada temperatur kalsinasi 500 °C mampu mendegradasi larutan fenol di bawah iradiasi sinar tampak hingga 91,51% dengan konstanta laju reaksi sebesar 0,0362 menit<sup>-1</sup>.

Kata kunci: Fenol, fotodegradasi, komposit, laju reaksi dan sinar tampak.

**PHOTODEGRADATION OF PHENOL UNDER VISIBLE LIGHT  
IRRADIATION USING Cu-N-CODOPED ZrTiO<sub>4</sub> COMPOSITE  
AS A HIGH-PERFORMANCE PHOTOCATALYST**

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**ABSTRACT**

Photodegradation of phenol using copper-nitrogen doped zirconium titanate composite (Cu-N-codoped ZrTiO<sub>4</sub>) has been conducted under visible light irradiation. This research aims to study the effect of Cu metal doping concentration and calcination temperature variation of 500, 700 and 900 °C on the character properties of Cu-N-codoped ZrTiO<sub>4</sub> in degrading phenol solution under visible light irradiation.

The photocatalyst material was synthesised via the sol-gel method starting with dissolving TTIP into ethanol. Zirconia suspensions containing 10% nitrogen (N) and copper (Cu) with varying concentrations of 1.0; 3.0; 5.0; 7.0; and 9.0% were mixed into the TTIP solution. The suspension mixture was centrifuged and the precipitate was taken for drying. The dried solids were calcined at 500, 700 and 900 °C. The composites were characterized using FTIR, XRD, SEM-EDX and SR-UV. Photodegradation of 10 ppm phenol solution was carried out at various irradiation times of 15, 30, 45, 60, 75, 90, 105, and 120 minutes under visible light. The concentration of phenol after photodegradation was measured using a UV-Vis spectrophotometer at a wavelength of 268 nm.

The results showed that the FTIR spectra of Cu-N- codoped ZrTiO<sub>4</sub> composite exhibited overlapping vibration of Zr-O and Ti-O-Ti in the wave numbers range of 500 - 650 cm<sup>-1</sup>. The diffractogram analysis of the composite indicate the presence of rutile crystal structure at 700 and 900 °C, while the anatase crystal structure is observed at 500 °C. The surface morphology of Cu-N-codoped ZrTiO<sub>4</sub> composite is round, rough, and homogeneous based on observation from SEM images. EDX analysis revealed the presence of the main elements Zr, O, Ti, Cu, and N in the synthesized material. The absorption edge analysis of SR-UV spectra resulted in a band gap energy of 2.61 eV, so the absorption edge of the Cu-N-codoped ZrTiO<sub>4</sub> composite can be active in the visible light region. The Cu-N-codoped ZrTiO<sub>4</sub> composite at a calcination temperature of 500 °C was able to degrade phenol solution under visible light irradiation up to 91.51% with a constant reaction rate of 0.0362 min<sup>-1</sup>.

**Keywords:** Composite, phenol, photodegradation, reaction rate and visible light.