

SINTESIS ZIRKONIUM TITANAT TERDOPING MANGAN-NITROGEN (Mn-N-CODOPED ZrTiO₄) SEBAGAI FOTOKATALIS UNTUK FOTODEGRADASI FENOL DI BAWAH IRADIASI SINAR TAMPAK

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INTISARI

Sintesis komposit zirkonium titanat terdoping mangan-nitrogen (Mn-N-codoped ZrTiO₄) sebagai fotokatalis telah berhasil dilakukan. Fotokatalis disintesis menggunakan metode sol-gel. Tujuan penelitian ini adalah mempelajari pengaruh variasi konsentrasi mangan dan temperatur kalsinasi terhadap karakteristik komposit dalam mendegradasi larutan fenol di bawah iradiasi sinar tampak.

Proses sintesis diawali dengan melarutkan TTIP ke dalam etanol. Suspensi zirkonia (ZrO₂) yang mengandung 10,0% nitrogen (N) dan mangan (Mn) dengan konsentrasi 1,0; 3,0; 5,0; 7,0 dan 9,0% diteteskan ke dalam larutan TTIP. Fotokatalis dikalsinasi pada temperatur 500, 700, dan 900 °C. Fotokatalis TiO₂ murni, ZrO₂ murni dan ZrO₂ terdoping mangan juga disintesis sebagai material pembanding. Komposit dikarakterisasi menggunakan FTIR, XRD, SEM-EDX, dan SRUV. Fotodegradasi larutan fenol 10 mg/L dilakukan pada waktu iradiasi 15, 30, 45, 60, 75, 90, 105, dan 120 menit di bawah sinar tampak. Konsentrasi larutan fenol setelah fotodegradasi ditentukan melalui pengukuran absorbansi menggunakan spektrofotometer UV-Vis pada panjang gelombang 269 nm.

Hasil penelitian menunjukkan bahwa FTIR komposit Mn-N-codoped ZrTiO₄ terdapat *overlapping* antara vibrasi Zr–O dan Ti–O–Ti pada bilangan gelombang 400-700 cm⁻¹. Analisis XRD menunjukkan struktur komposit yang terbentuk pada temperatur kalsinasi 500°C adalah *anatase* dan *monoklinik*. Struktur *rutile* terbentuk pada temperatur kalsinasi 700 dan 900°C. Analisis SEM menunjukkan bahwa morfologi komposit berbentuk bulat. Hasil spektrum EDX membuktikan adanya unsur utama Zr, O, Ti, Mn dan N pada material yang disintesis. Penambahan dopan Mn dan N berpengaruh pada pergeseran tepi serapan ke daerah sinar tampak yaitu pada panjang gelombang 464 nm dengan nilai energi celah pita sebesar 2,67 eV. Komposit mampu mendegradasi larutan fenol di bawah iradiasi sinar tampak hingga 59,149% dengan laju reaksi sebesar 0,0121 ppm/menit.

Kata kunci: fenol, fotodegradasi, mangan-nitrogen, sol-gel, ZrTiO₄.

SYNTHESIS OF MANGAN-NITROGEN CODOPED ZIRCONIUM TITANATE (Mn-N-CODOPED ZrTiO₄) AS A PHOTOCATALYST FOR PHOTODEGRADATION OF PHENOL UNDER VISIBLE LIGHT IRRADIATION

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ABSTRACT

The synthesis of manganese-nitrogen-doped zirconium titanate composite (Mn-N-codoped ZrTiO₄) as a photocatalyst has been successfully conducted. The photocatalyst was synthesized using the sol-gel method. The aim of this research was to study the influence of manganese concentration variation and calcination temperature on the characteristics of the composite in degrading phenol solutions under visible light irradiation.

The synthesis process began by dissolving TTIP in ethanol. Suspensions of zirconia (ZrO₂) containing 10.0% nitrogen (N) and manganese (Mn) with concentrations of 1.0; 3.0; 5.0; 7.0 and 9.0% were dripped into the TTIP solution. The photocatalyst was calcined at temperatures of 500, 700, and 900 °C. Pure TiO₂, pure ZrO₂, and manganese-doped ZrO₂ were also synthesized as reference materials. The composites were characterized using FTIR, XRD, SEM-EDX, and SRUV. Photodegradation of a 10 mg/L phenol solution was carried out at irradiation times of 15, 30, 45, 60, 75, 90, 105, and 120 minutes under visible light. The concentration of phenol solution after photodegradation was determined by measuring absorbance using a UV-Vis spectrophotometer at a wavelength of 269 nm.

The research results indicate that the FTIR analysis of the Mn-N-codoped ZrTiO₄ composite shows an overlapping between the Zr–O and Ti–O–Ti vibrations in the wavenumber range of 400-700 cm⁻¹. XRD analysis reveals that the composite structure formed at a calcination temperature of 500°C consists of anatase and monoclinic phases. Rutile structure is formed at calcination temperatures of 700 and 900°C. SEM analysis showed that the composite morphology was spherical and homogeneous. The EDX spectrum results proved the presence of main elements Zr, O, Ti, Mn, and N in the synthesized material. The addition of Mn and N dopants affected the shift of absorption edge to the visible light region at a wavelength of 464 nm with a bandgap energy value of 2.67 eV. The composite was capable of degrading phenol solution under visible light irradiation by up to 59.149% with a reaction rate of 0.0121 ppm/minute.

Keywords: phenol, photodegradation, manganese-nitrogen, sol-gel, ZrTiO₄.