

## DEGRADASI FENOL DI LINGKUNGAN PERAIRAN MENGUNAKAN Fe, N-CODOPED ZrTiO<sub>4</sub> SEBAGAI FOTOKATALIS RESPONSIF TERHADAP SINAR TAMPAK

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### INTISARI

Fotokatalis Fe, N-codoped ZrTiO<sub>4</sub> (Fe, N-ZT) telah berhasil disintesis melalui metode *sol-gel*. Tujuan penelitian ini adalah untuk menganalisis dampak variasi konsentrasi dopan besi dan suhu kalsinasi terhadap sifat dan aktivitas fotokatalitik material dalam proses degradasi fenol di bawah iradiasi sinar tampak. Dalam proses sintesis Fe, N-ZT, prekursor Ti dihasilkan dengan melarutkan titanium tetraisopropoksida dalam etanol absolut, dilanjutkan dengan penambahan suspensi ZrO<sub>2</sub> serta dopan nitrogen (N) dengan konsentrasi 10% dan besi (Fe) dengan konsentrasi 1-5%. Seluruh material telah dikalsinasi pada suhu 500 °C selama 4 jam, sementara variasi suhu kalsinasi dilakukan pada suhu 500, 700 dan 900 °C. Material kemudian dikarakterisasi menggunakan metode FTIR, XRD, SEM-EDX dan SRUV. Uji aktivitas fotokatalis Fe, N-ZT dalam proses degradasi fenol telah dilakukan dengan menggunakan konsentrasi awal fenol sebesar 10 ppm, sementara fotokatalis ditambahkan dengan perbandingan 1:1 (b/v) antara fotokatalis dan larutan fenol. Proses iradiasi dilakukan di bawah sinar tampak dalam rentang waktu 0-120 menit. Analisis fenol yang terdegradasi kemudian dilakukan menggunakan spektrofotometer UV-vis pada panjang gelombang 270 nm.

Pada hasil analisis FTIR, teramati adanya puncak yang terindikasi pada rentang 400-700 dan 1095 cm<sup>-1</sup>, masing-masing menunjukkan vibrasi Fe-O-Ti dan Fe-O-Zr. Perubahan dalam kisi material dikonfirmasi melalui karakterisasi XRD, perubahan ini dipicu oleh proses *doping* yang mampu menghambat pertumbuhan fase TiO<sub>2</sub> *anatase*. Perubahan fase kristal untuk TiO<sub>2</sub> dan ZrO<sub>2</sub> juga terjadi karena variasi suhu kalsinasi. Morfologi Fe, N-ZT digambarkan oleh analisis SEM yang menunjukkan material berbentuk bulat (*spherical*) dan homogen. Pada permukaan material tersebut juga terlihat adanya aglomerasi yang disebabkan oleh konsentrasi dopan yang tinggi. Keberadaan unsur utama Zr, Ti, O, Fe, dan N pada fotokatalis hasil sintesis teridentifikasi oleh spektrum EDX. Pada analisis SRUV, teramati pergeseran merah tepi serapan fotokatalis ke wilayah sinar tampak yang dipengaruhi oleh *codoping* Fe dan N. Pada material 5% Fe, N-ZT yang mengalami proses kalsinasi pada suhu 700 °C, tercatat memiliki nilai energi celah pita terendah, yakni 2,66 eV. Pada material fotokatalis 5% Fe, N-ZT yang telah mengalami proses kalsinasi pada suhu 500 °C, diperoleh persentase degradasi larutan fenol tertinggi, yakni sebesar 50,53%. Konstanta laju yang teramati mencapai 0,00504 ppm per menit.

Kata kunci: Fe, N-codoped ZrTiO<sub>4</sub>, fenol, fotodegradasi, fotokatalis, sinar tampak

## **PHENOL DEGRADATION IN AQUEOUS ENVIRONMENT USING Fe, N-CODOPED ZrTiO<sub>4</sub> AS A VISIBLE LIGHT-RESPONSIVE PHOTOCATALYST**

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### **ABSTRACT**

The Fe, N-codoped ZrTiO<sub>4</sub> (Fe, N-ZT) photocatalyst was synthesized using the sol-gel method. This study aimed to investigate the influence of varying concentrations of iron dopants and calcination temperature on the properties and photocatalytic activity of the material in the degradation of phenol under visible light irradiation. During the synthesis of Fe, N-ZT, the Ti precursor was generated by dissolving titanium tetraisopropoxide in absolute ethanol. Subsequently, a suspension of ZrO<sub>2</sub> and nitrogen (N) dopant at a concentration of 10% was added, along with iron (Fe) dopant concentrations ranging from 1% to 5%. The entire material underwent calcination at 500 °C for 4 hours, while calcination temperature variation was carried out at 500, 700, and 900 °C. Characterization of the material was conducted using FTIR, XRD, SEM-EDX, and SRUV techniques. The photocatalytic activity of Fe, N-ZT in phenol degradation was assessed using an initial phenol concentration of 10 ppm, with the photocatalyst added at a 1:1 (w/v) ratio with the phenol solution. Visible light irradiation was employed for 0-120 minutes. Analysis of degraded phenol was performed using a UV-vis spectrophotometer with a wavelength of 270 nm.

In the FTIR analysis results, peaks were observed within the range of 400-700 and 1095 cm<sup>-1</sup>, indicating the vibrations of Fe-O-Ti and Fe-O-Zr, respectively. Changes in the material lattice were confirmed through XRD characterization, these changes were caused by the doping processes that could inhibit the growth of the TiO<sub>2</sub> anatase phase. Changes in the crystal phase of the material also occurred due to variations in calcination temperature. The morphology of Fe, N-ZT was depicted by SEM analysis, which showed the material was spherical and homogeneous. On the surface of the material also showed agglomeration caused by high dopant concentration. The presence of the main elements Zr, Ti, O, Fe, and N in the synthesized photocatalyst was identified by EDX spectrum analysis. In the SRUV analysis, a red shift of the photocatalyst absorption edge to the visible light region was observed which influenced by Fe and N codoping. In the 5% Fe, N-ZT material subjected to calcination at 700 °C, the lowest band gap energy value was recorded at 2.66 eV. For the 5% Fe, N-ZT photocatalyst material that underwent calcination at 500 °C, the highest percentage of phenol degradation was obtained at 50.53%. The observed rate constant reached 0.00504 ppm per minute.

Keywords: Fe, N-codoped ZrTiO<sub>4</sub>, phenol, photocatalyst, photodegradation, visible light