

Nanokomposit Chitosan/ZnO-MoS₂ Sebagai Fotokatalis Untuk Degradasi Methylene Blue dengan Optimasi RSM-CCD = Chitosan/ZnO-MoS₂ Nanocomposite as Photocatalyst for Methylene Blue Degradation with RSM-CCD Optimization

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Abstrak

Pewarna methylene blue (MB) merupakan pewarna fenotiazin kationik bersifat toksik sulit terdegradasi. Kombinasi kitosan, MoS₂, dan ZnO terintegrasi secara efektif untuk meningkatkan performa fotokatalis melalui peningkatan adsorpsi permukaan dan aktivitas fotodegradasi di bawah cahaya tampak. Pada penelitian ini berhasil sintesis nanokomposit Chitosan/ZnO-MoS₂ metode menggunakan casting dan didukung dengan karakterisasi menggunakan SEM, TEM, FTIR, XRD, UV-Vis, dan UV-DRS. Penambahan MoS₂ 30 w/w% terhadap nanopartikel ZnO diperoleh nanokomposit ZnO-MoS₂ menghasilkan energi band gap 2,81 eV dan ukuran partikel rata – rata ZnO-MoS menggunakan TEM didapatkan 74,68 nm. Aplikasi nanokomposit sebagai fotokatalis digunakan metode response surface methodology-central composite design (RSM-CCD) terhadap zat warna MB sebagai model respons, dengan parameter independen MoS₂ terhadap ZnO, kitosan terhadap ZnO-MoS₂, dan waktu iradiasi. Kondisi optimal dari studi ini adalah penambahan MoS₂ terhadap ZnO 30 w/w%, penambahan kitosan terhadap ZnO-MoS sebesar 3 w/v%, dan waktu iradiasi 120 menit didapatkan energi band gap sebesar 2,69 eV serta berhasil mendegradasi 89,196% MB dibawah sinar tampak. Studi kinetika degradasi MB mengikuti orde satu semu dengan konstanta laju reaksi 0,0048 menit⁻¹. Penggabungan biopolimer kitosan dengan komposit ZnO-MoS menawarkan pendekatan yang ramah lingkungan untuk meningkatkan efisiensi fotokatalitik dalam proses degradasi zat warna.

.....Methylene blue (MB), a cationic phenothiazine dye, is toxic, difficult to degrade naturally. The integration of chitosan, MoS, and ZnO effectively enhances photocatalytic performance by improving surface adsorption and photodegradation activity under visible light. In this research, the Chitosan/ZnO-MoS₂ nanocomposite was successfully synthesized using the casting method, characterized using SEM, TEM, FTIR, XRD, UV-Vis, and UV-DRS. The addition of MoS₂ 30 w/w% to ZnO nanoparticles yielded ZnO-MoS nanocomposite with a band gap energy of 2.81 eV and an average particle size of 74.68 nm as measured by TEM. The application of the nanocomposite as a photocatalyst was optimized using the response surface methodology-central composite design (RSM-CCD), with methylene blue degradation as the response model. The independent variables included the MoS-to-ZnO ratio, the chitosan-to-ZnO-MoS ratio, and irradiation time. The optimal conditions were achieved with 30 w/w% MoS-to-ZnO, 3 w/v% chitosan-to-ZnO-MoS, and irradiation time of 120 minutes, resulting in a reduced band gap energy of 2.69 eV and 89.196% degradation of MB under visible light. The degradation kinetics of MB followed a pseudo-first-order reaction, with a rate constant of 0.0048 min⁻¹. The incorporation of the biopolymer chitosan into the ZnO-MoS composite presents an environmentally friendly approach to enhancing photocatalytic efficiency in dye degradation processes.