

Green Synthesis Nanokomposit ZnO/CeMnO₃ menggunakan Ekstrak Daun Bayam Raja (*Amaranthus viridis*) dan Uji Aktivitas Fotokatalitiknya terhadap Degradasi Malasit Hijau = Green Synthesis ZnO/CeMnO₃ Nanocomposite using Green Amaranth (*Amaranthus viridis*) Leaf Extract and The Photocatalytic Activity Test on Malachite Green Degradation

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Abstrak

Pada penelitian ini, sintesis nanokomposit ZnO/CeMnO₃ dilakukan dengan metode *green synthesis* menggunakan ekstrak daun bayam raja (*Amaranthus viridis*). Metabolit sekunder pada ekstrak digunakan sebagai basa lemah dan *capping agent* dalam proses sintesis nanokomposit. Untuk mengidentifikasi sifat optik dan struktural nanopartikel serta nanokomposit, dilakukan dikarakterisasi dengan instrumen UV-Vis DRS, FTIR, XRD, Photoluminescence, SEM-EDX, dan HRTEM. Nanokomposit ZnO/CeMnO₃ menunjukkan nilai *band gap* yang menurun dibanding ZnO, yaitu pada 2,68 eV. Selain itu, karakterisasi HRTEM mengkonfirmasi terbentuknya ZnO/CeMnO₃ *heterojunction* dengan *d spacing* ZnO (110) = 0,162 nm dan *d spacing* CeMnO₃ = 0,31 nm. Ukuran partikel rata-rata ZnO/CeMnO₃ adalah 7,46 nm. Aktivitas fotokatalitik nanokomposit ZnO/CeMnO₃ diuji untuk mendegradasi larutan malasit hijau di bawah sinar tampak selama 120 menit serta dibandingkan dengan aktivitas fotokatalitik nanopartikel ZnO dan CeMnO₃. Persentase fotodegradasi malasit hijau oleh ZnO/CeMnO₃, CeMnO₃, dan ZnO masing-masing bernilai 92,69%; 69,46%; dan 37,5%. Kinetika reaksi fotodegradasi nanokomposit ZnO/CeMnO₃ mengikuti model orde satu semu dengan konstanta laju senilai $1,031 \times 10^{-2} \text{ min}^{-1}$. Peningkatan aktivitas fotokatalitik nanokomposit ZnO/CeMnO₃ disebabkan karena adanya penurunan bandgap ZnO dan rendahnya laju fotorekombinasi *electron-hole* yang masing-masing dibuktikan oleh analisis spektroskopi UV-Vis DRS dan *photoluminescence*.

.....In this study, ZnO/CeMnO₃ nanocomposites were synthesized using green synthesis method using green amaranth leaf extract (*Amaranthus viridis*). The secondary metabolites present in the extract were utilized as a weak base and capping agent during the synthesis processes. To identify the optical and structural properties of the synthesized nanoparticles and nanocomposites, characterization was performed using UV-DRS, FTIR, XRD, Photoluminescence, SEM-EDX, and HRTEM instruments. The synthesized ZnO/CeMnO₃ nanocomposite showed a decreased band gap value compared to ZnO, at 2,68 eV. Additionally, XRD and HRTEM characterization confirmed the formation of the ZnO/CeMnO₃ composite on a nanometer scale with the average particle size at 7,46 nm. The photocatalytic activity of the ZnO/CeMnO₃ nanocomposite was tested by degrading a malachite green solution under visible light for 120 minutes and compared with the photocatalytic activity of ZnO and CeMnO₃ nanoparticles. The percentages of malachite green photodegradation by ZnO/CeMnO₃, CeMnO₃, and ZnO were 92,69%; 69,46%;

and 37,5%, respectively. The photodegradation reaction kinetics of the ZnO/CeMnO₃ nanocomposite were also determined to follow a pseudo-first-order model with a rate constant of $1.031 \times 10^{-2} \text{ min}^{-1}$. The increase in photocatalytic activity of the ZnO/CeMnO₃ nanocomposite is due to a decrease in the bandgap and a low rate of electron-hole photorecombination which is proven by UV-Vis DRS and photoluminescence analysis respectively.