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Structural and Photocatalytic Properties of Sol–Gel Synthesized $CeMnO_3$ Rare Earth Perovskite

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Introduction :

The contamination of water resources by organic pollutants, including synthetic dyes remains a pressing environmental concern. In this work, a novel photocatalyst—cerium manganese oxide ($CeMnO_3$)—was synthesized via a straightforward citrate-based sol–gel method to address this issue. Comprehensive characterization of the material was conducted using techniques such as XRD, FTIR, FESEM, BET, XPS, and UV-Vis DRS to assess its structural, morphological, and optical properties.

$CeMnO_3$ demonstrated strong photocatalytic activity under visible light, achieving degradation efficiency 74.6 % for Methyl Orange, within 120 minutes, including an initial 30-minute dark equilibration period, at pH 9. The material's high performance is largely due to its narrow optical bandgap of 2.40 eV, which promotes efficient light absorption and charge carrier separation.

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Further investigation into operational parameters—such as pH level, catalyst loading, and pollutant concentration—revealed that the photocatalytic efficiency could be significantly enhanced . These enhancements position $CeMnO_3$ as a promising photocatalyst for eco-friendly and effective water purification. Continued research into its long-term durability and scalability is essential to support its application in practical wastewater treatment technologies.

Résultats :

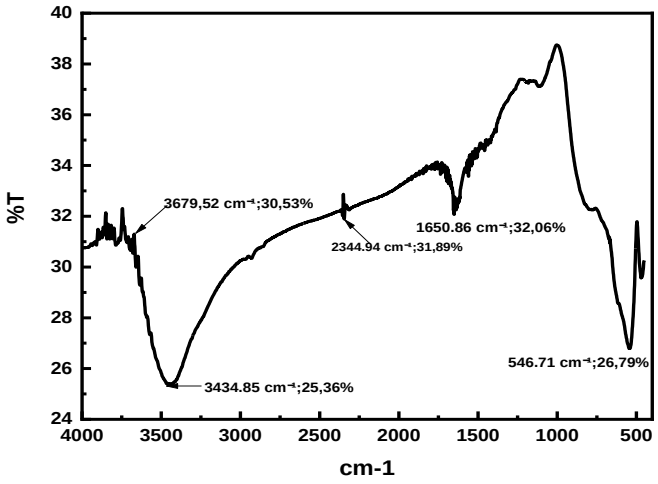

Fig 1. Characteristic FTIR spectra of CeMnO3 nanocomposites.

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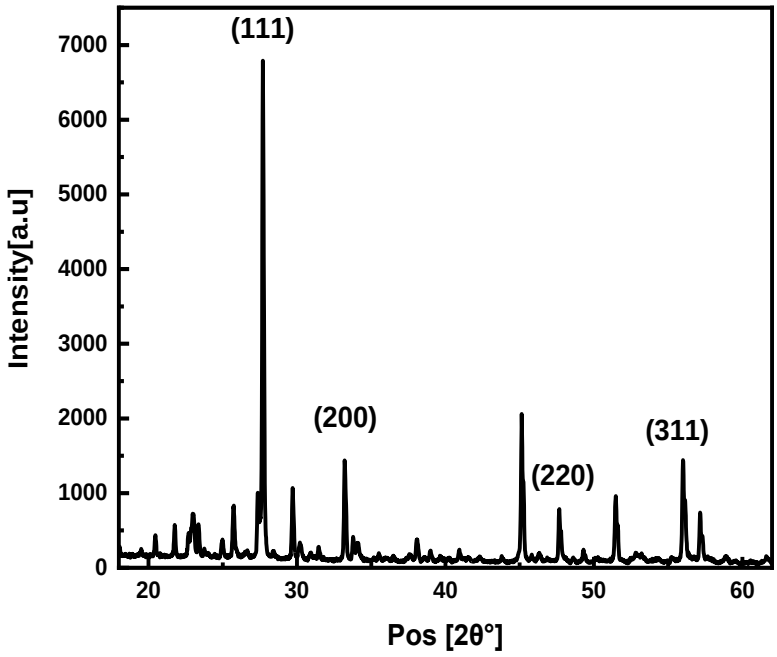

Fig. 2. XRD patterns of the synthesized perovskite CeMnO3

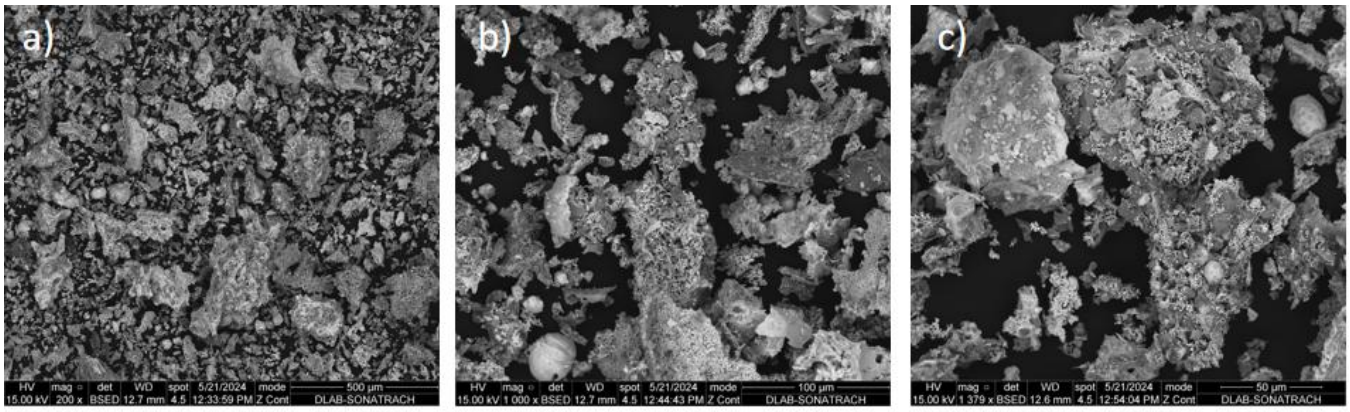

Fig.3.(a) FESEM micrographs of CeMnO3 material taken at×200 magnification; **(b)** FESEM image of a material taken at×1000 magnification; **(c)** FESEM image of the catalyst taken at ×1379 magnification.

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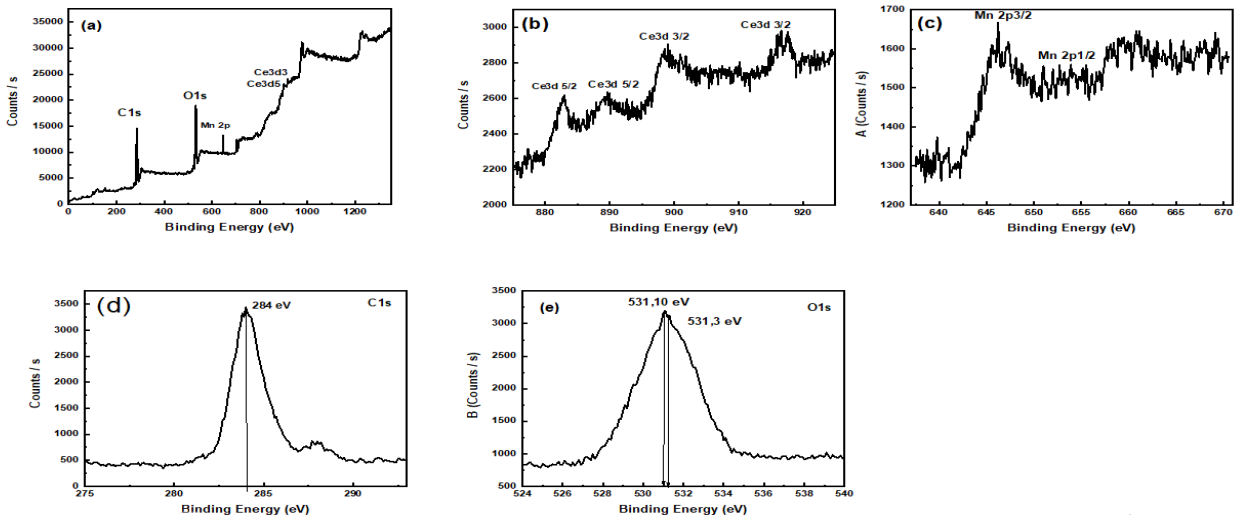

Fig 4.(a) XPS Surve yof CeMnO3 perovskite nanoparticle; **(b)** XPS scan of Ce 3d, **(c)** XPS scan of Mn 2p , **(d)** XPS scan of C1s,**(e)** XPS scan of O1s.

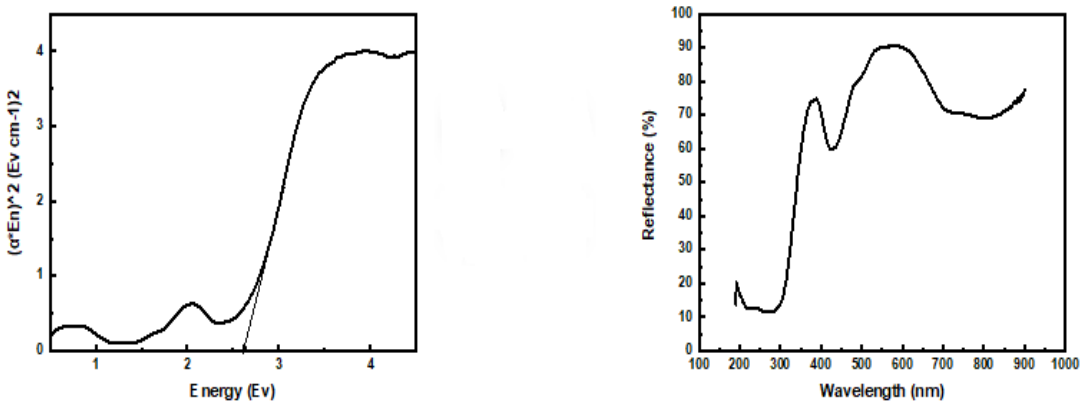

Fig.5.(a). Tauc plot for determination of bandgap of CeMnO3. (**b)**UV–Vis absorption spectrum of CeMnO3.

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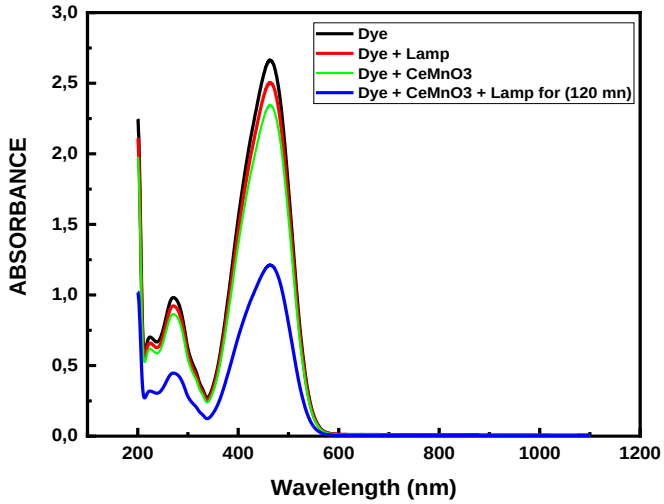

Fig.6.UV-Vis Absorption Spectra of Methyl Orange Dye in Different Conditions

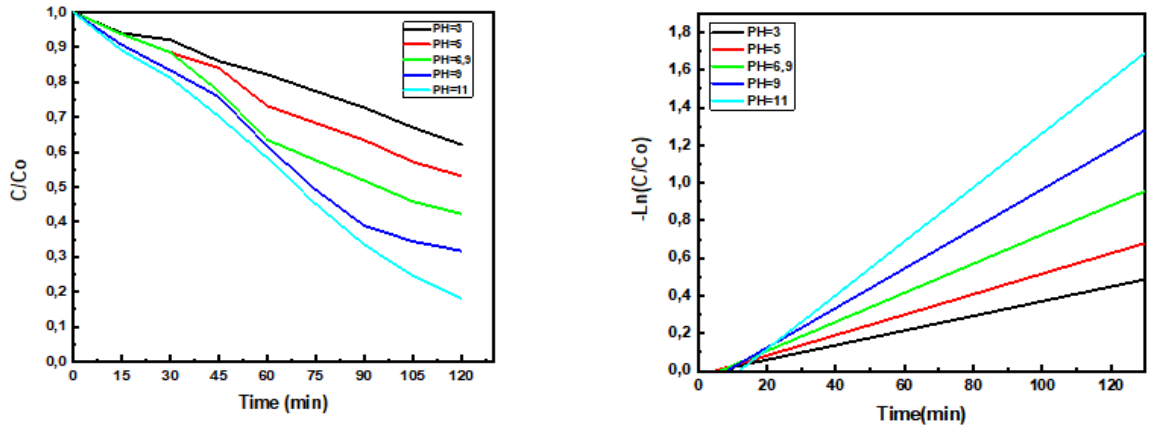

Fig7) a) Efect of PH on a photocatalytic degradation of MO Dye. **b)** degradation kinetics of MO Dye with various PH.

Conclusion :

In this study, a mixed perovskite-type oxide, $CeMnO_3$, was synthesized via the sol-gel method and characterized using various analytical techniques to determine its crystal structure, morphology, elemental composition, and other optical characteristics. The synthesized CeMnO3 catalyst possesses a narrow bandgap of 2.40 eV,and mesoporous morphology with important specific areaallowing it ideal for utilization under visible light illumination.

The photocatalyst demonstrated a maximum removal efficiency of 74.6%, effectively reducing the MO concentration to 2.5 ppm. A decrease in initial dye concentration led to a corresponding increase in the quantity of degraded pollutant. However, the highest degradation rate was observed at a lower MO concentration of 5 ppm. Optimal photocatalytic performance was achieved at pH

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11, with a degradation efficiency of 81.8% after 120 minutes for a 10 ppm MO solution, considering the system's absorption/desorption equilibrium.

Furthermore,the reusability test revealed that the material retained its performance, exhibiting only a 22% decline in photocatalytic efficiency after four consecutive cycles of use.

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