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Nanostructured CuO, ZnO and ZnO/CuO thin films synthesized by SILAR method and their enhanced photocatalytic activity for methylene blue degradation

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INTRODUCTION & AIM

Thin films of ZnO, CuO, and ZnO/CuO heterostructures were synthesized using the SILAR (Successive Ionic Layer Adsorption and Reaction) method with 50 deposition cycles, ensuring controlled thickness and uniform growth. The structural, morphological, and optical properties of the thin films were systematically characterized. X-ray diffraction (XRD) analysis confirmed the crystalline nature and phase purity of ZnO and CuO, as well as the successful formation of the heterostructure. Scanning electron microscopy (SEM) revealed uniform surface morphology with well-distributed grains, indicating good film quality. UV–Vis spectroscopy showed that ZnO films mainly absorb in the ultraviolet region, while CuO extends absorption into the visible region. The ZnO/CuO heterostructure exhibited improved optical absorption over a broader spectral range, thereby enhancing its photocatalytic potential. The photocatalytic performance of the films was evaluated through the degradation of methylene blue under light irradiation. A 5 ppm solution of methylene blue was used as a pollutant model. Results demonstrated that the ZnO/CuO heterostructure exhibited superior photocatalytic activity compared to individual ZnO and CuO films. This improvement is attributed to enhanced charge separation and reduced electron–hole recombination at the ZnO-CuO interface. Overall, the study highlights the potential of SILAR-fabricated ZnO/CuO thin films as efficient photocatalysts for environmental remediation applications.

METHOD

Thin film deposition

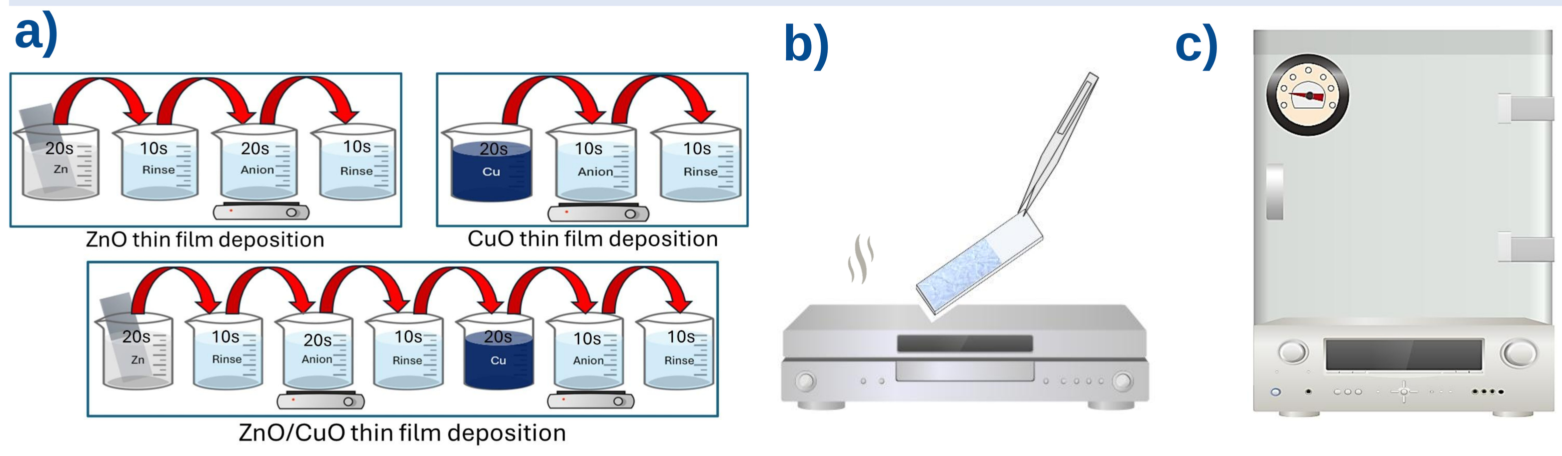


Figure 1. Thin film deposition, a) SILAR method, b) drying (100 °C), and c) calcination (400 °C, 2h).

Photocatalytic test for the degradation of methylene blue

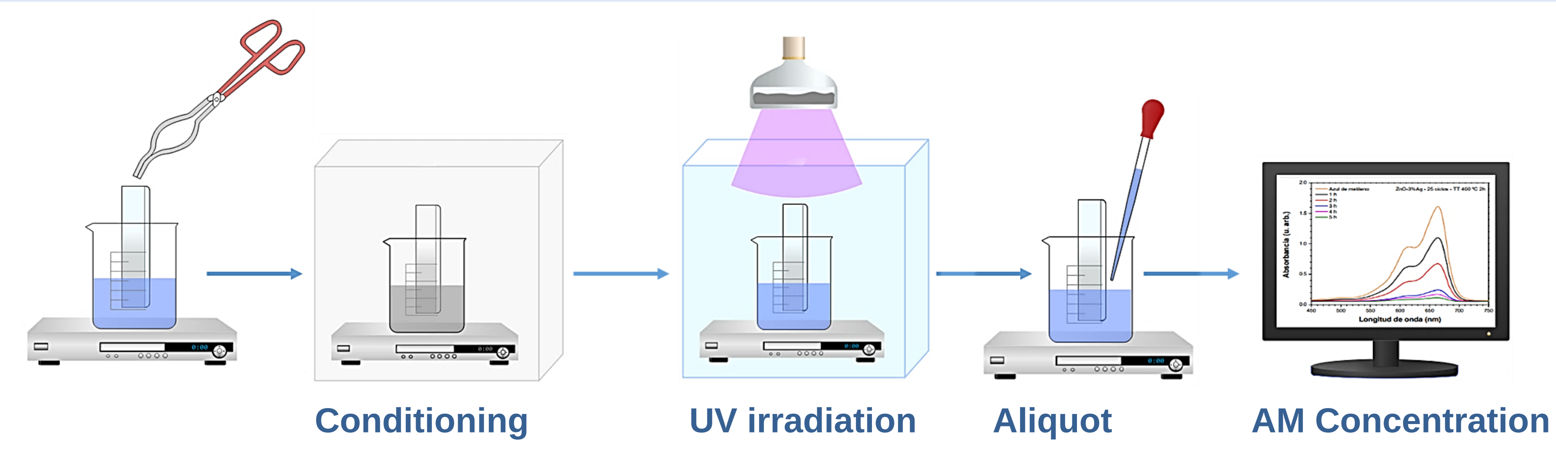
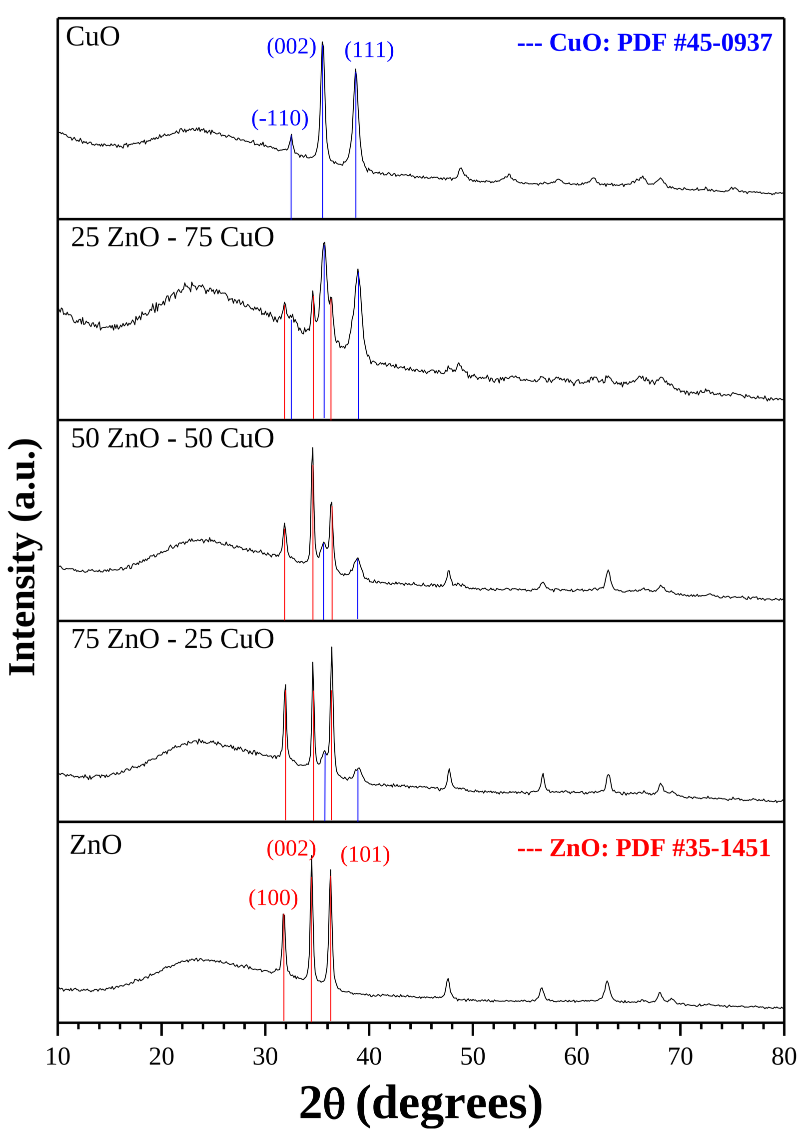


Figure 2. Photocatalytic test.

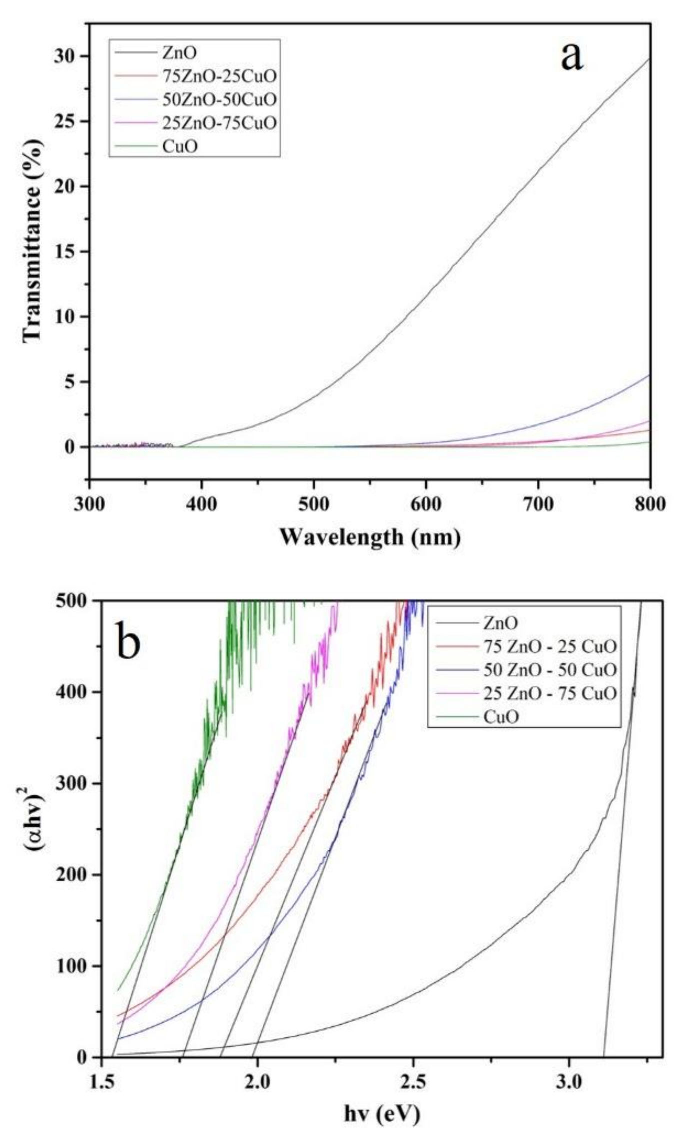
RESULTS & DISCUSSION

Structural analysis: XRD



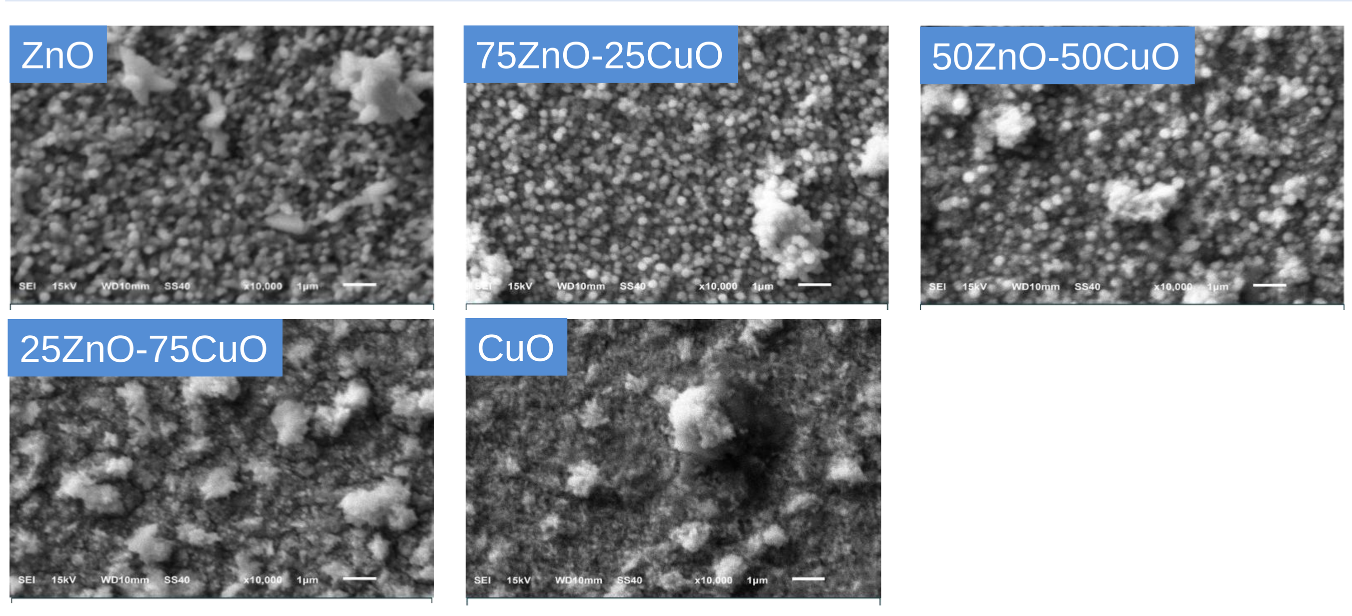
Sample	Plane	Crystallite size (nm)
ZnO	(002), ZnO	31.25
75ZnO-25CuO	(002), ZnO	37.97
50ZnO-50CuO	(002), ZnO	32.39
50ZnO-50CuO	(111), CuO	9.27
25ZnO-75CuO	(111), CuO	9.56
CuO	(111), CuO	14.90

Optical properties: UV-Vis

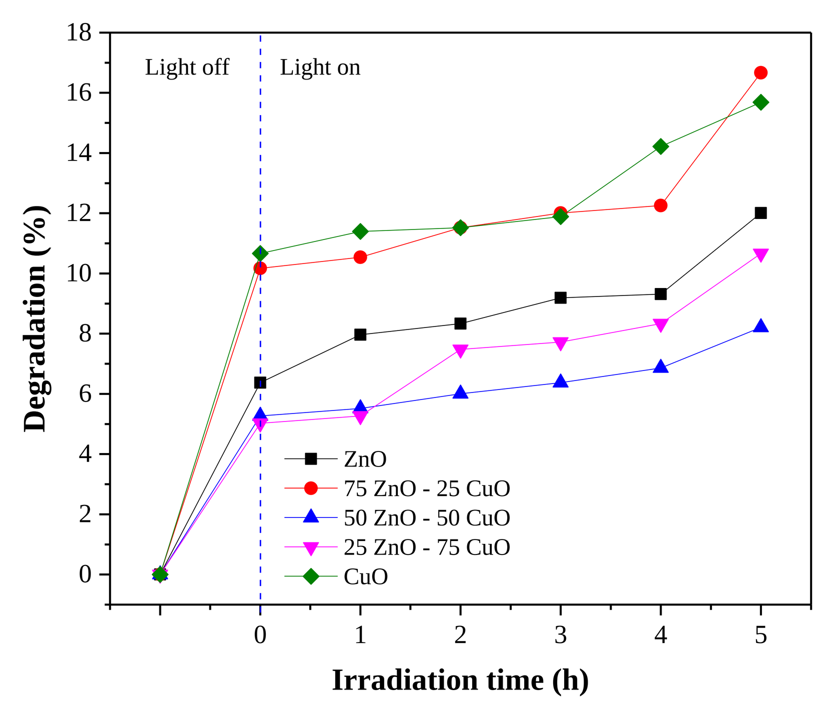


Sample	Band gap (eV)
ZnO	3.12
75ZnO-25CuO	1.88
50ZnO-50CuO	1.97
25ZnO-75CuO	1.76
CuO	1.53

Surface morphology: SEM



Photocatalytic test



CONCLUSIONS

ZnO, CuO, and ZnO/CuO thin films were successfully synthesized using a modified Successive Ion Layer Adsorption and Reaction (SILAR) method. X-ray diffraction (XRD) analysis confirmed the presence of both wurtzite ZnO and monoclinic CuO phases. Ultraviolet-visible (UV-Vis) analysis showed a redshift in absorption and a corresponding decrease in the bandgap, which enhances visible-light absorption. The 75ZnO-25CuO thin film achieved a 16.50% degradation of methylene blue.

ACKNOWLEDGMENT

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