

Supporting Information

Highly efficient and stable AgI-CdO nanocomposites for photocatalytic and antibacterial activity

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2.1. Chemicals required

Cadmium Nitrate Tetrahydrate ($\text{Cd}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$) was bought from Sisco Research Laboratories Pt. Ltd, and Silver Nitrate and Potassium Iodide were obtained from Thermo Fisher Scientific, India Pvt. Ltd.; The organic compounds, such as Paracetamol, methylene blue (MB), and Rhodamine B(RhB), were acquired from Sigma Aldrich. Other compounds like terephthalic acid, isopropyl alcohol (IPA), disodium ethylenediaminetetraacetate (EDTA-2Na), and benzoquinone (BQ) were procured from Merck. All the chemicals were used without additional purification. The solutions of organic compounds were prepared in freshly double distilled water.

2.2. Synthesis of pure CdO

A solution of $\text{Cd}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$ (0.1 M, 4.627 g) was prepared by dissolving in distilled water (150 ml) under stirring for 1 h at room temperature, and to it, an aqueous solution of NaOH (1 M) was added dropwise with stirring to give a white precipitate product. The pH of the solution was maintained at 10 and it was further stirred for 10 h at room temperature to complete the growth of precipitate. The precipitate was filtered and washed several times with water and then dried at 80 °C for 12 h. Finally, the synthesized product was calcined for 2 h at 400 °C.

2.3. Synthesis of pure AgI

For the preparation of AgI NPs, 0.2 M AgNO₃ was dissolved in distilled water (60 mL) and rapidly stirred for 30 min in the dark. A KI solution (60 ml, 0.2 M) was added dropwise to produce a light yellow precipitate, which was stored in the dark for 2 h under stirring. The product (AgI) was filtered as a light yellow precipitate, washed with water, and dried at 70 °C for 12 h.

2.4. Synthesis of AgI-CdO nanocomposite

The photocatalyst (AgI-CdO) nanocomposite was synthesized by the deposition–precipitation method under ambient conditions. The prepared CdO (1 g) was suspended in water (100 mL) through stirring and sonication for 1 h followed by the addition of KI (0.1025 g) slowly with stirring for 30 min. A solution of ammonium hydroxide (2.5 mL, 25 wt % NH₃) was prepared with AgNO₃ (0.105 g) in the dark, added to the above mixture, and stirred for 12 h in the dark. The mixture so obtained was filtered, washed with water, and dried overnight at 80° C. The product was designated as 5 wt% AgI-CdO. Likewise, the samples of 10 wt% AgI-CdO and 15 wt% AgI-CdO were also synthesized by adjusting the theoretical wt% of AgI under similar conditions.

2.5. Materials characterization

All the prepared materials were characterized by using standard analytical techniques, including X-ray beam diffractometer (XRD), Fourier Transform infrared spectroscopy (FTIR), Diffuse reflectance spectroscopy (UV-vis DRS), and Scanning electron microscope (SEM). The synthesized samples phase structure was monitored on an X-ray beam diffractometer (Smart Lab S E.) using graphite monochromatic radiation [Cu K α radiation (1.540 Å)], with a voltage of 30 kV and a 15 mA current at an output speed of 10°/min in the range of 5-80° at the value of 2 θ .

The FTIR of all the synthesized materials was recorded on Perkin Elmer Spectrum 2 with KBr disc. For a better understanding of the optical properties of samples, UV-vis diffuse reflectance spectrophotometer (DRS, Perkin Elmer Lambda 35) has been used. The SEM study was conducted with the JEOL JSM-6510L instrument to know the morphology of prepared samples. The EDX analysis was carried out to detect the elements present in the synthesized material and mapping images of the samples were made on an energy dispersive X-ray detector (EDX) equipped with a microscope (JEOL-JSM-6510). A transmission electron microscope (TEM) was employed to investigate further the internal morphology of the samples using the JEOL-JEM 2100 instrument operating at 120 keV. Fluorescence Spectrometer (Perkin Elmer LS 55) was used to measure the photoluminescence spectra of the synthesized materials. The room temperature dielectric measurements in the frequency range of 75 kHz–5 MHz were carried out using an LCR meter (Model No. SH-1000, Wayne-Kerr India).

2.6. Trapping experiment

The well-known trapping experiments were performed to know about the key reactive species involved in the degradation process over the most active catalyst using. In this study, irradiation of an aqueous solution of RhB was carried out using different scavengers such as isopropyl alcohol (2 mM), benzoquinone (2 mM), and EDTA-2Na (2 mM) in the presence of 10 % AgI-CdO nanocomposite to capture the hydroxyl radicals, superoxide radicals, and holes, respectively. The reaction conditions were kept similar to those used for photodegradation reactions, where the catalyst was added after the addition of scavengers into the dye solution. On a quantitative basis, the hydroxyl radical was estimated by the terephthalic acid photoluminescence (TA-PL) process. In a typical procedure, 220 mg of the photocatalyst was taken in 220 mL aqueous solution containing (TA (5×10^{-4} M) and NaOH (2×10^{-3} M). Upon

excitation at 315 nm, the hydroxyl radicals generated may react with terephthalic acid to give a fluorescent adduct (2-hydroxy- terephthalic acid), which was monitored spectrofluorimetrically.

2.7. Evaluation of photocatalytic study

All photocatalytic tests were carried out in a photoreactor made of Pyrex glass. During the experiment, eco-friendly light radiation (visible light radiation, $\lambda \geq 400$, halogen lamp (500W)) under continuous atmospheric oxygen bubbling and temperature system adjustment at 25 °C by flowing cold water was used to estimate the decomposition of various organic pollutants such as MB, RhB, and paracetamol in aquatic solution with prepared catalysts. As revealed in our previous work [1], the procedure connected to the expulsion of organic contaminates was used.

In this experiment, 200 mg of the required catalyst was visibly suspended in 200 mL organic contaminant solution (RhB, MB, and paracetamol 12 ppm), then sonicated and agitated for 30 minutes to scatter the catalyst particles into the solution and to ensure the adsorption-desorption.

The sunlight experiments were conducted in the same immersion well photochemical reactor. The reactor containing the dye solution with a suspended catalyst was illuminated under the sunlight during the period from 10.00 am to 3.00 pm (light intensity 116 $\mu\text{W}/\text{cm}^2$) with stirring, bubbling of air, and proper cooling of the solution. The samples were collected at various time intervals and centrifuged (6000 rpm) to remove the photocatalyst and monitored spectrophotometrically at their respective wavelengths. With the use of the following equation, the degradation percentage (D.P) of all compounds under investigation was calculated (Eq. S1).

$$\text{DE (\%)} = (C_0 - C_t) / C_0 \times 100 \quad (\text{S1})$$

Where, C_0 is the sample's initial concentration before being exposed to light, and C_t is the concentration at the end of irradiation. The irradiated mixture of an aqueous suspension of

paracetamol in the presence of a catalyst was also monitored by HPLC to see the by-products formed during the photooxidation process. The HPLC (waters) consisted of a reversed-phase C18 column, UV-vis detector (model 2489) at 254 nm, with a single pump (model 515). In this experiment, the mobile phase was a 50/50 combination of water and methanol, with a flow rate of one mL/min.

2.8. In vitro antibacterial studies

For this study, Agar well diffusion method was employed for the evaluation of the antibacterial activity of the synthesized pure and nanocomposite materials against known pathogenic bacteria [*S. aureus* as a gram-positive bacterium and two gram-negative bacteria (*E. coli* ATCC 25922 and *P. aeruginosa* ATCC PA01)] as Model Test strains. The model test strains were grown overnight at 37 °C and 120 RPM to achieve 10⁴ CFU (colony-forming units). These cultures were subcultured on sterile Muller Hinton agar plates in a laminar flow hood by spread plate method. 6mm wells were cut out of the plates using gel puncture and sealed with 10 µL soft agar. Different concentrations from each catalyst (50 and 100 mg/l) were made and dispensed in the allotted wells of each test strain plate. A 10 µg ampicillin disc was placed on each plate as the positive control, and DMSO was used as the negative control. The plates were then incubated for 16 hours at 37 °C under visible light, and the zone of inhibition (ZOI) was measured using a scale after 24 hours.

3.2. FTIR Analyses

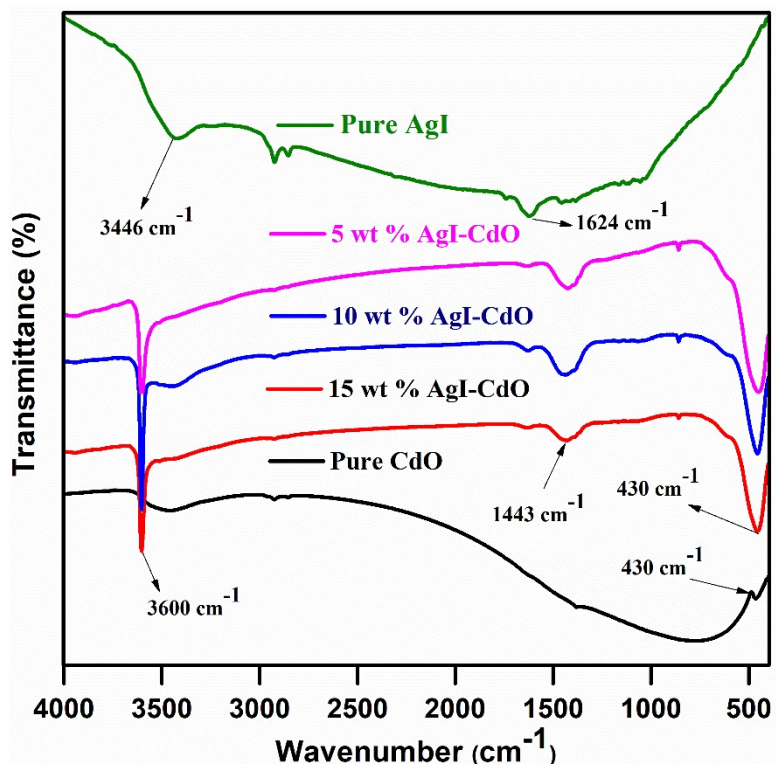


Fig. S1. FT-IR spectra of as-synthesized AgI, CdO, and different 10 wt % AgI-CdO nanoparticles.

3.5. Elemental mapping analyses

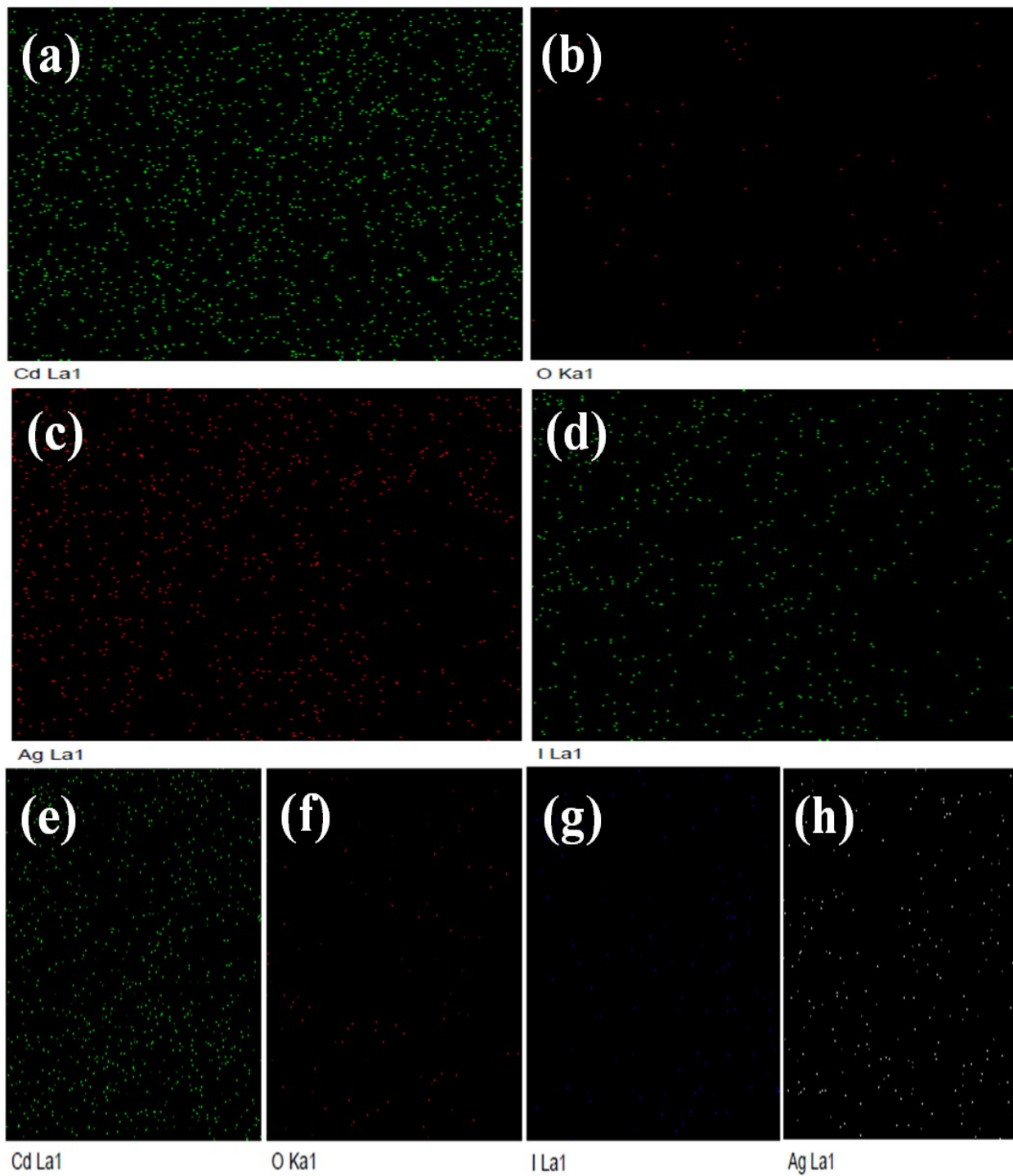


Fig. S2. EDX elemental mappings image of nanoparticle samples of pure CdO (a-b), AgI (c-d) and 10 wt % AgI-CdO nanocomposite (e-h).

HPLC

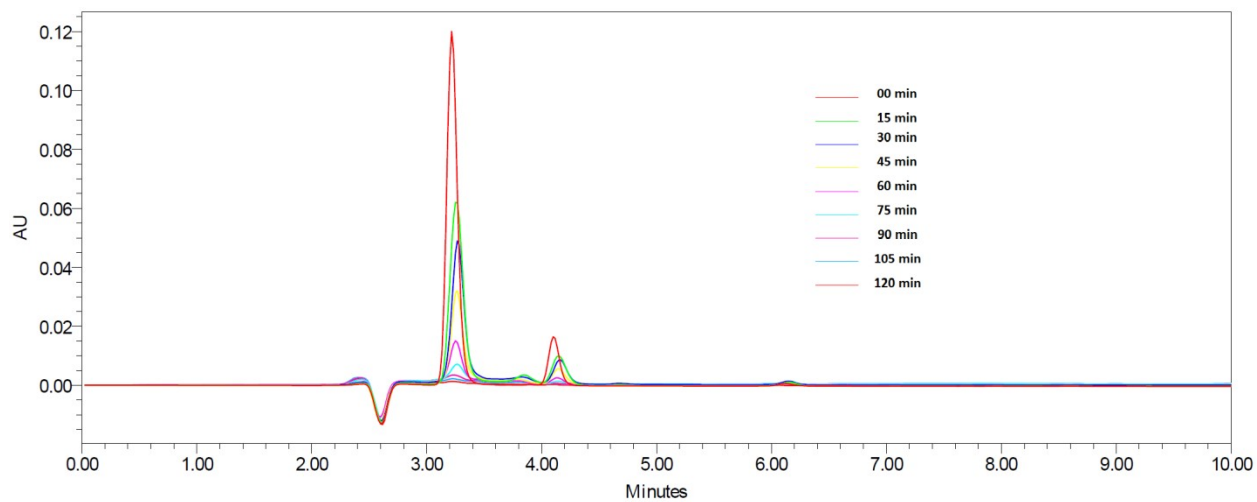


Fig. S3. HPLC chromatogram of an aqueous solution of paracetamol over a 10 wt % AgI-CdO nanocomposite at various time intervals using a visible-light source.

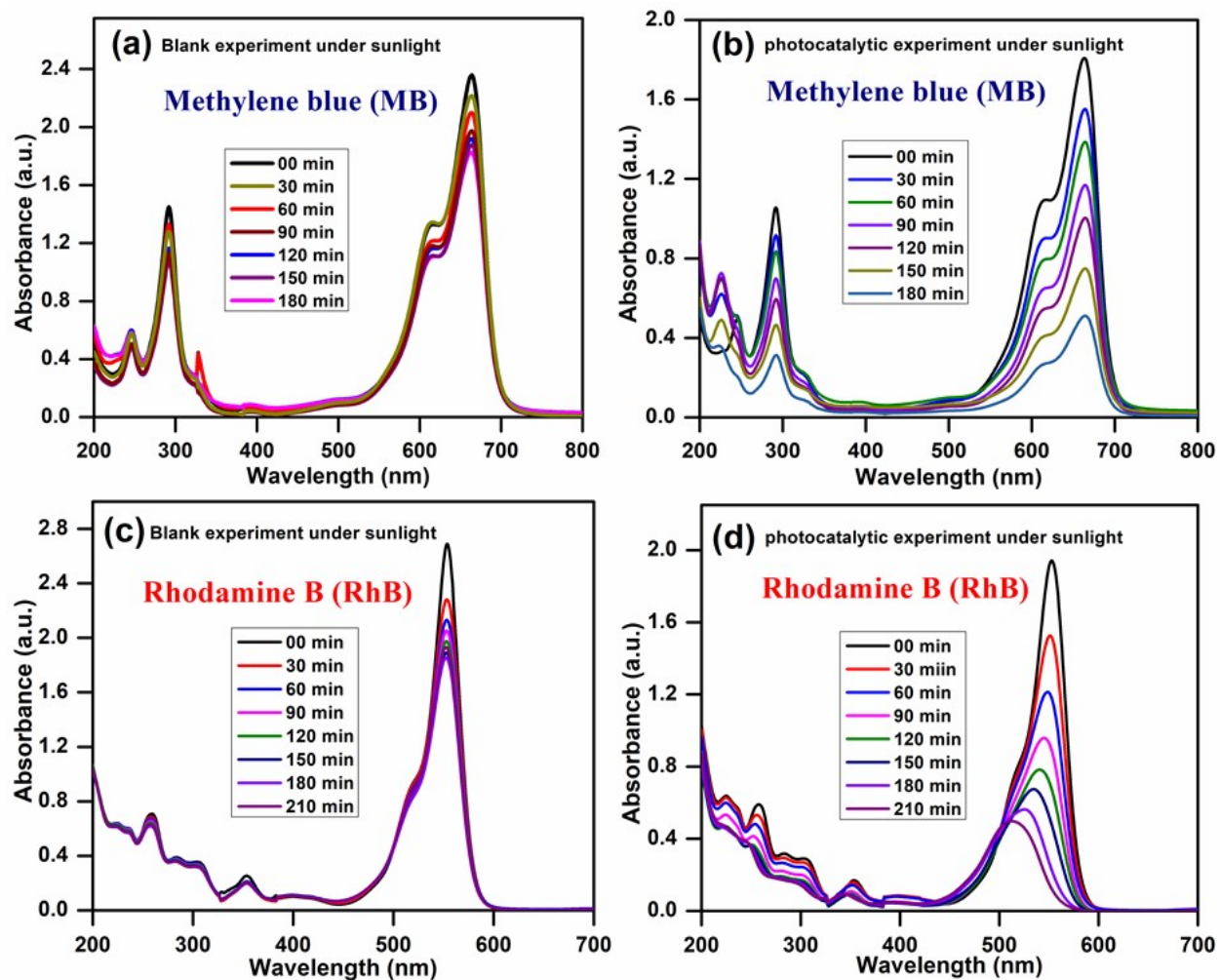


Fig.S4. The change in absorbance intensity as a function of time on the illumination of an aqueous suspension of MB (a,b) and RhB (c,d) in the absence and presence of a catalyst (10 wt % AgI-CdO) under sunlight.

References

1. U. Alam, A. Khan, D. Bahnemann, M. Muneer, J. Environ. Chem. Eng. 2018, 6, 4885-4898.