

## Cadmium and bismuth dopants' synergistic effect on the photocatalytic dye degradation potential of ZnO/CdO

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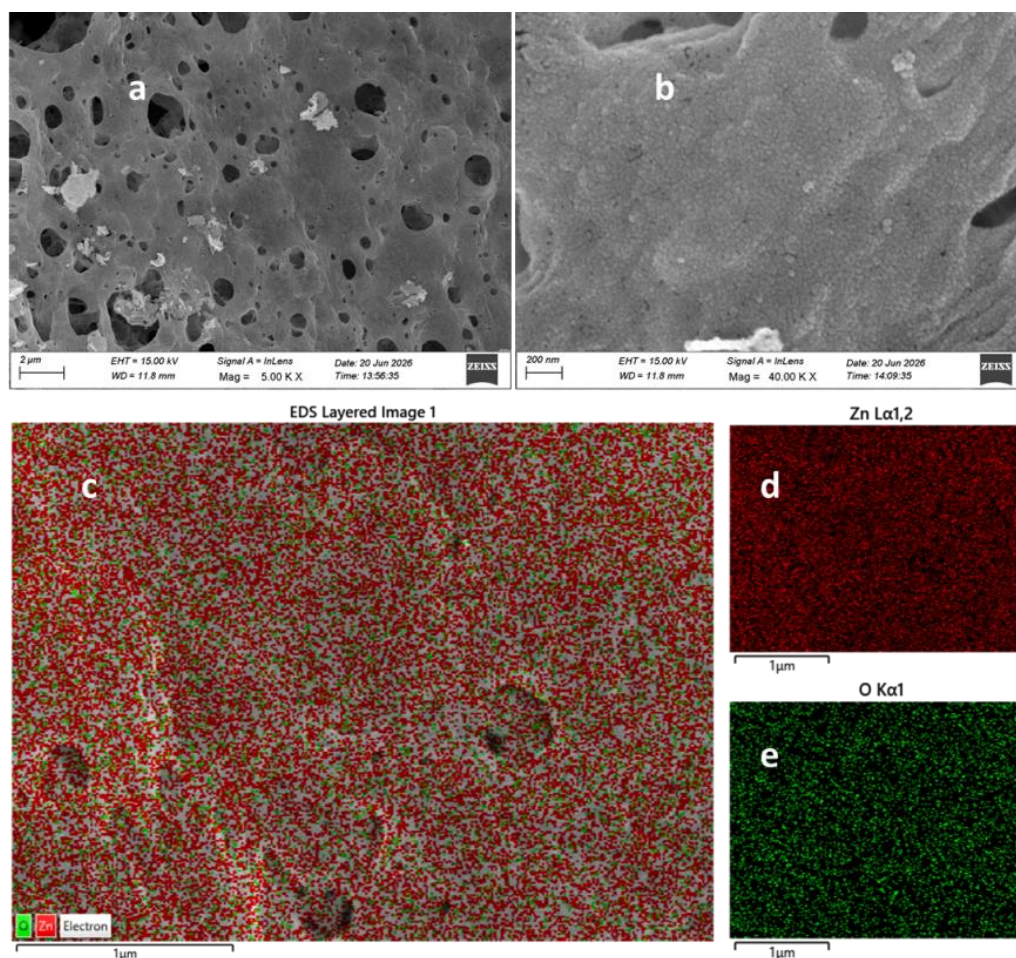
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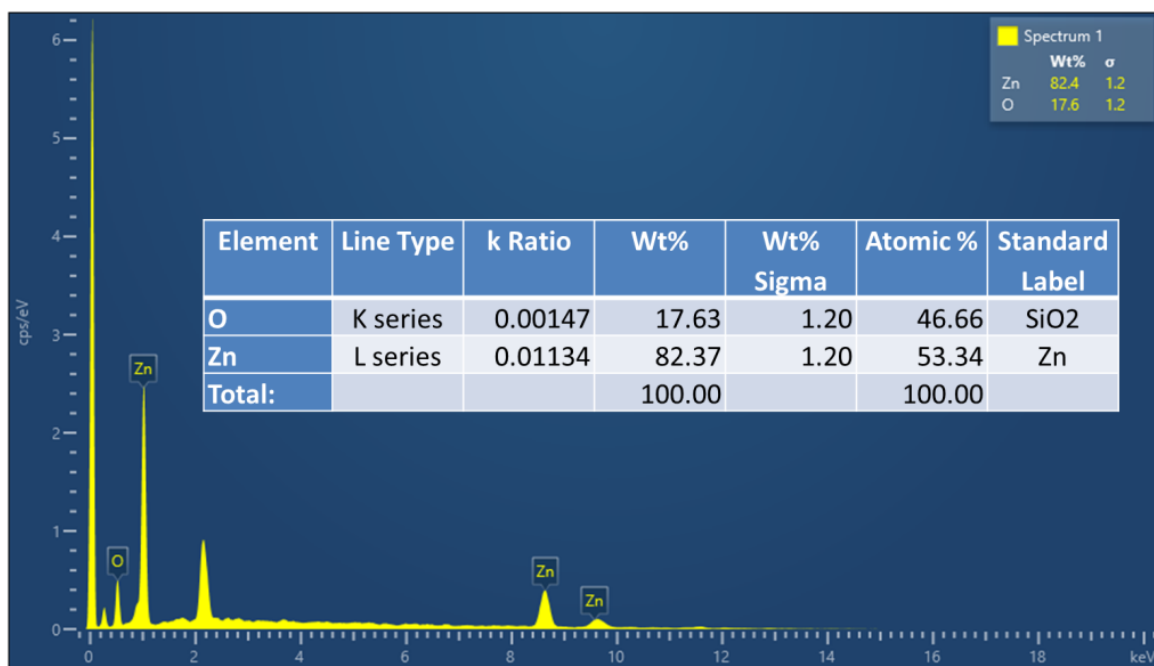
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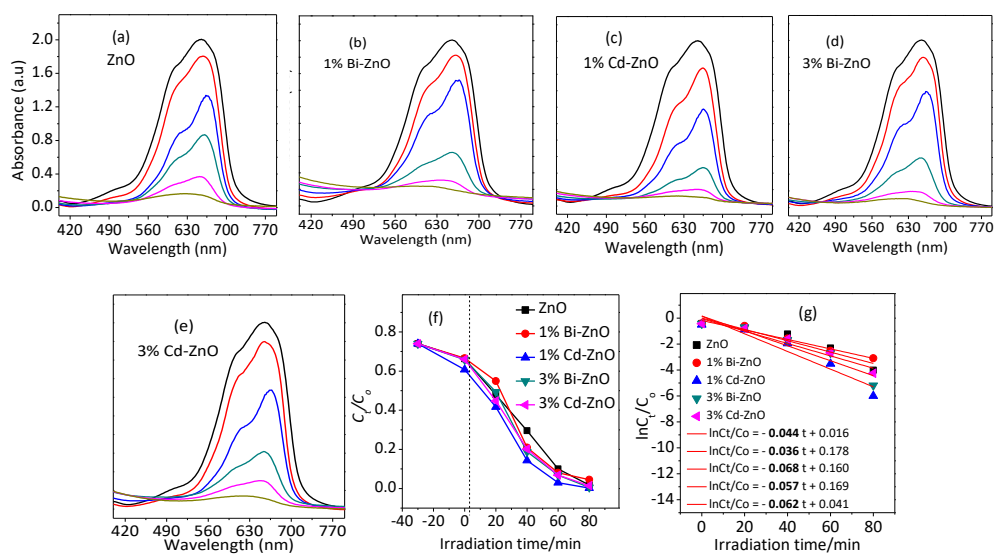
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**Fig. S1.** ZnO NPs morphological analysis using FESEM-EDS: **(a and b)** FESEM images at two scale bar values of 2 μm and 200 nm; **(c)** the EDS layered image; and **(d and e)** elemental mapping analysis results of Zn and O elements.



**Fig. S2.** The compositional and elemental mapping analysis: EDX spectrum for ZnO NPs.



**Fig. S3.** absorbance versus wavelength photocatalysis plots of (a) ZnO, (b) 1%Bi-ZnO, (c) 1%Cd-ZnO, (d)3% Bi-ZnO, (e) 3%Cd-ZnO (f)  $C/C_0$  vs. time, and (g)  $\ln(C/C_0)$  vs. time plots.

**Table S1.** The amount in mol and in gram for synthesized 1, 3, and 5% CBZ heterostructures.

|    | Zn (NO <sub>3</sub> ) <sub>2</sub> •6H <sub>2</sub> O | Cd (NO <sub>3</sub> ) <sub>2</sub> •4H <sub>2</sub> O | Bi (NO <sub>3</sub> ) <sub>3</sub> •5H <sub>2</sub> O |
|----|-------------------------------------------------------|-------------------------------------------------------|-------------------------------------------------------|
| 1% | 1.59 x 10 <sup>-2</sup> mol (4.712 g)                 | 8.0 x 10 <sup>-5</sup> mol (0.0247 g)                 | 8.0 x 10 <sup>-5</sup> mol (0.0388 g)                 |
| 3% | 1.552 x 10 <sup>-2</sup> mol (4.617 g)                | 2.4 x 10 <sup>-4</sup> mol (0.074 g)                  | 2.4 x 10 <sup>-4</sup> mol (0.116 g)                  |
| 5% | 1.52 x 10 <sup>-2</sup> mol (4.522 g)                 | 4.0 x 10 <sup>-4</sup> mol (0.123 g)                  | 4.0 x 10 <sup>-4</sup> mol (0.194 g)                  |

**Table S2.** N<sub>2</sub> adsorption-desorption isotherm plots of ZnO NPs.

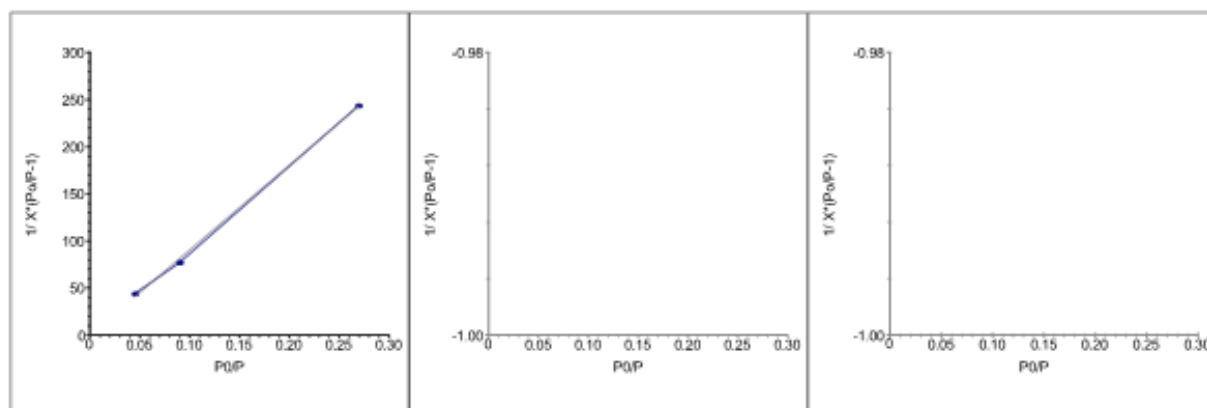
Horiba Instruments, Inc.  
SA-9600 Series Surface Area Analyzer

Analysis Report  
Apr/02/2026

|             |                        |               |               |
|-------------|------------------------|---------------|---------------|
| Customer    | : Guta Amanu           | Operator ID   | : SARA        |
| Description | : Different Experiment | Analysis Date | : Apr/02/2026 |
| Filename    | : ZnO.sa2              | Analysis Time | : 15:07:07    |

| Condition Settings |             |           |                         |
|--------------------|-------------|-----------|-------------------------|
| Room Temp          | : 27.0 (°C) | Atm. Pres | : 700.0 (mm)            |
| Gas Used           | : Nitrogen  | Gas Conc  | : 0.300, 0.000, 0.000 % |

|                                   | Channel: 1   | Channel: 2  | Channel: 3  |
|-----------------------------------|--------------|-------------|-------------|
| Sample Name                       | ZnO          |             |             |
| Tube Number                       | 1            | 0           | 0           |
| Tare Weight                       | 10.0780 (gm) | 0.0000 (gm) | 0.0000 (gm) |
| Sample Weight                     | 10.1600 (gm) | 0.0000 (gm) | 0.0000 (gm) |
| Degas Temp.                       | 150 (°C)     | 0 (°C)      | 0 (°C)      |
| Degas Time                        | 60 (min)     | 0 (min)     | 0 (min)     |
| Surface Area (M <sup>2</sup> /gm) | 26.99        | 0.000       | 0.000       |
| Slope                             | 901.299      | -1.#IO      | -1.#IO      |
| Intercept                         | 0.282        | -1.#IO      | -1.#IO      |
| Vm                                | 0.001        | -1.#IO      | -1.#IO      |
| BET Const                         | 3192.472     | -1.#IO      | -1.#IO      |
| Pearson Coef                      | 0.999        | 0.000       | 0.000       |
| X[1] - 0.269                      | 243.741      | 1.#IO       | 1.#IO       |
| X[2] - 0.090                      | 77.164       | 1.#IO       | 1.#IO       |
| X[3] - 0.045                      | 43.929       | 1.#IO       | 1.#IO       |



**Table S3.** N<sub>2</sub> adsorption-desorption isotherm plots of 3% Cd-Bi co-ZnO heterostructure.

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Analysis Report  
Apr/02/2026

|             |                        |               |               |
|-------------|------------------------|---------------|---------------|
| Customer    | : Guta Amanu           | Operator ID   | : SARA        |
| Description | : Different Experiment | Analysis Date | : Apr/02/2026 |
| Filename    | : 3% CBZ.sa2           | Analysis Time | : 13:20:24    |

|                    |             |           |                         |
|--------------------|-------------|-----------|-------------------------|
| Condition Settings |             |           |                         |
| Room Temp          | : 26.0 (°C) | Atm. Pres | : 700.0 (mm)            |
| Gas Used           | : Nitrogen  | Gas Conc  | : 0.300, 0.000, 0.000 % |

|                                   | Channel: 1   | Channel: 2  | Channel: 3  |
|-----------------------------------|--------------|-------------|-------------|
| Sample Name                       | 3% CBZ       |             |             |
| Tube Number                       | 1            | 0           | 0           |
| Tare Weight                       | 9.9950 (gm)  | 0.0000 (gm) | 0.0000 (gm) |
| Sample Weight                     | 10.1150 (gm) | 0.0000 (gm) | 0.0000 (gm) |
| Degas Temp.                       | 150 (°C)     | 0 (°C)      | 0 (°C)      |
| Degas Time                        | 60 (min)     | 0 (min)     | 0 (min)     |
| Surface Area (M <sup>2</sup> /gm) | 50.555       | 0.000       | 0.000       |
| Slope                             | 570.700      | -1.#/O      | -1.#/O      |
| Intercept                         | 2.934        | -1.#/O      | -1.#/O      |
| Vm                                | 0.002        | -1.#/O      | -1.#/O      |
| BET Const                         | 195.530      | -1.#/O      | -1.#/O      |
| Pearson Coef                      | 1.000        | 0.000       | 0.000       |
| X[1] - 0.269                      | 157.118      | 1.#/O       | 1.#/O       |
| X[2] - 0.179                      | 104.298      | 1.#/O       | 1.#/O       |
| X[3] - 0.090                      | 54.685       | 1.#/O       | 1.#/O       |

