Visible Light-Induced Photocatalytic Degradation of Methylene Blue Using Copper-Doped Carbon Dots One-Step Derived from CCA-Wood

S1. Methods:

S1.1. Effect of MB Concentrations

Different concentrations of MB solutions of 10, 20, 30, 40, 50, 100, 150, and 300 mg/L were prepared to investigate the effect of MB concentrations on the photocatalytic degradation experiment. 30 mg of CCA-CDs and MB solutions of different concentrations were added to glass beakers with artificial visible light from a bulb for 60 min with stirring by a magnetic stirrer. The solid-to-liquid ratio for CCA-CDs and MB solution was 1:1000. Other operational parameters were conducted, as explained in Section 2.3.

S1.2. Effect of CCA-CD Content

The obtained CCA -CDs varying from 10 to 30 mg were added into 30 mL of MB solution to explore the catalyst content's effect on MB's degradation efficiency. The concentration of MB was set as 50 mg/L, and other variables were kept constant. The degradation study was conducted as described above.

S1.3. Effect of pH

The pH of the dye solution was controlled to successive initial values between 2.2 and 9 with the addition of $C_6H_8O_7$ (0.1 M) or Na2HPO4 (0.2 M). MB was added into the varied pH buffer solution to configure the concentration of MB of 50 mg/L. In each experiment, 30 mg of CCA-CDs was added into a 100 mL glass beaker. Then, 30 mL of 50 mg/L MB solution with different pH values was added to the glass beaker. The degradation study was performed under different pH buffer solutions, as described in Section 2.3.

S1.4. Kinetic Studies

A calibration curve was obtained by measuring the absorbance value (A) of different concentrations of MB aqueous solution using a UV-visible spectrophotometer corresponding to the maximum wavelength of 664 nm. The absorbance values of several dilutions of MB solution (0.5, 1, 2, 3, 4, 5, 6, 7.5, 10, 12, 15 mg/L) were recorded by UV-visible spectroscopy to get a standard curve. The maximum absorbance wavelength for the MB identifying at 664 nm was observed in its UV spectrum date. The absorbance values were then plotted against concentrations (c), and a line of best fit was generated in the Origin (Figure S6). The equation obtained from the line of best fit was A = 0.02947 + 0.16535c (R^2 = 0.998). This equation was used to calculate MB concentrations in the following experiments.

To determine the kinetics of the photodegradation rate, kinetic experiments were carried out by placing 100 mL of MB solution with the initial concentration of 100, 150, and 300 mg/L in a 250 mL glass beaker. Then, CCA-CDs (100 mg) were added to the solution, and the mixture was agitated at 170 rpm using a magnetic agitator at room temperature under artificial visible light from a bulb. Samples were collected at different time intervals and were analyzed by UV-visible spectroscopy at 664 nm. Two repeated measurements were conducted for each sample under identical conditions. The amount of MB adsorbed onto CCA-CDs was calculated, and different kinetic models (Pseudo-first-model and Pseudo-second-model) were conducted to fit the experimental process.

The adsorption amount of MB at time t, q_t (mg/g), was calculated by the following equation:

$$q_t = (V(C_0 - C_t))/W \qquad (S1)$$

where C_0 is the initial concentration, C_t is the concentration at time t, V is the volume of MB solution, and W is the mass of CCA-CDs.

S1.5. Isotherm Studies

A 30 mL MB solution of the initial concentrations varying from 50–400 mg/L was placed in a 100 mL glass beaker. Then, 30 mg of CCA-CDs were added to the solution, and the mixture was agitated at 170 rpm using a magnetic agitator at room temperature for 42 h. Other operational parameters were the same as in the above section of 2.3. The adsorption amount of MB at equilibrium was calculated by the equation of (1). Several isotherm models were applied to fit the process after calculating the adsorption amount of MB at different time intervals. The equilibrium data for the degradation of MB in this study were analyzed using the models of Langmuir, Freundlich, Redlich–Peterson, and Sips (Freundlich–Langmuir) equations [1–4].

S2. Result

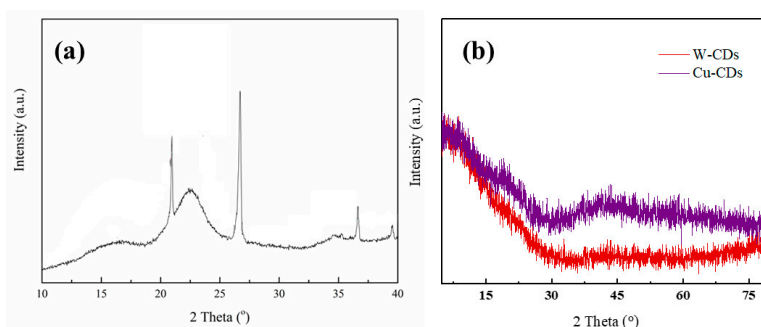**Figure S1.** waste chromate-copper-arsenate wood particles

Figure S2. XRD of (**a**) CCA-treated wood and (**b**) the obtained CDs
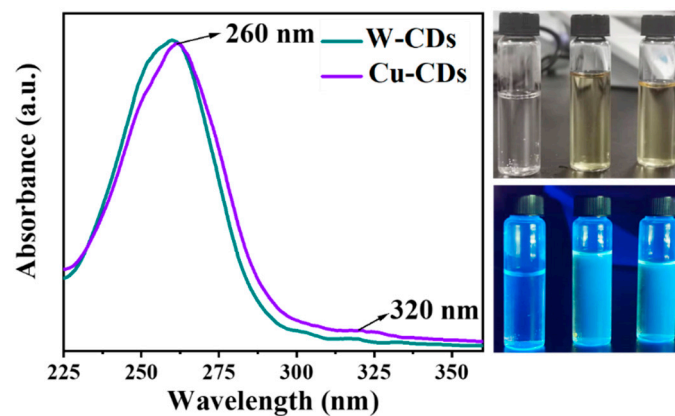
Figure S3. UV absorption spectra of CCA-CDs and W-CDs, fluorescence images of CCA-CDs in normal light and at 365 nm UV light.

Figure S4. Digital photograph of photoluminescence of copper-doped carbon dot solution (stored at 4 °C for 24 months).
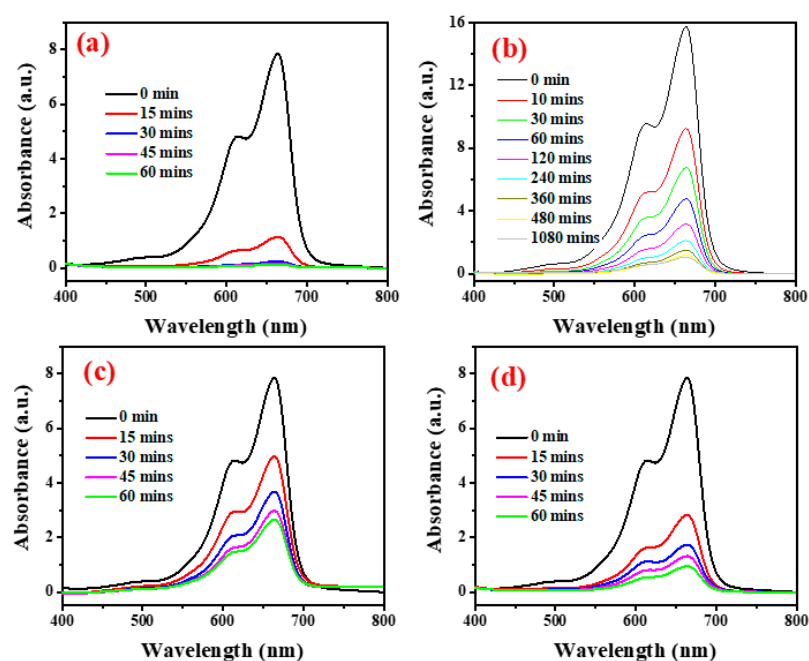

Figure S5. Absorption spectra of MB treated by CCA-CDs under various experimental conditions: the MB concentrations of 50 mg/L (**a**) and 100 mg/L (**b**), the CCA-CDs contents of 10 mg with a MB concentrations of 50 mg/L (**c**), and the pH of 3.0 (**d**) with the solid to liquid ratio of 1:1.
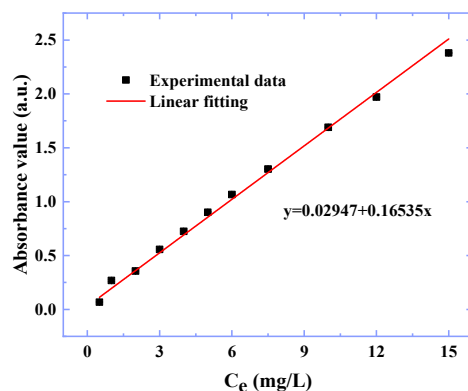
Figure S6. The calibration curve of MB.

References

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