

Supporting information

For

Effect of morphologies of CuS upon the photo-catalytic degradation of organic dyes

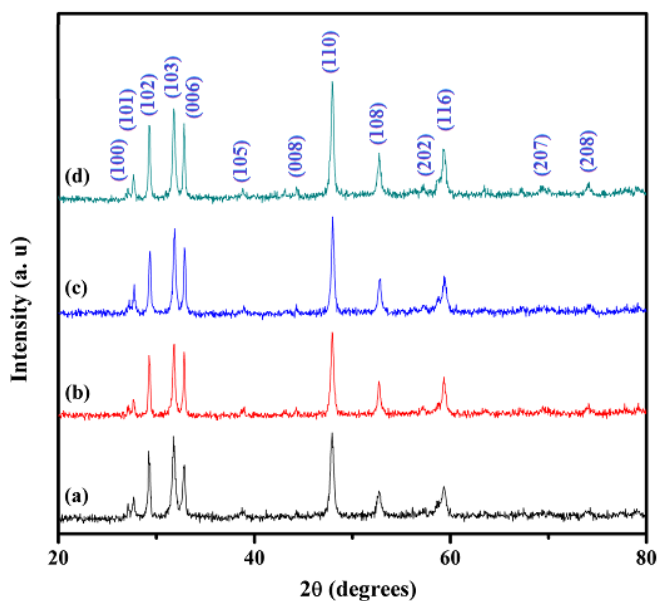


Figure S1. XRD patterns of the as prepared CuS products at different reaction durations, under the same typical experimental conditions [$\text{Cu}(\text{NO}_3)_2 \cdot 3\text{H}_2\text{O}$ = 1 mmol, sulfur = 2 mmol, ethylene glycol = 40 ml at 180°C] (a) 4h, (b) 8h (SWCO), (c) 12h (DWCO), (d) 18h (MWCO).

Effect of sulfur and Cu^{2+} sources

Figure S2 displays the SEM images of the product while utilizing different sulfur and Cu^{2+} sources under the same typical experimental process. All of the particles obtained appear to be in the form of flowers comprising of beautifully arranged nanoplates while using $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ as the copper source (Figure S2a). Whereas, when $\text{Cu}(\text{CH}_3\text{COO})_2 \cdot 5\text{H}_2\text{O}$ was adopted as the Cu^{2+} source (Figure S2b) the entire product is in the form of aggregated architectures comprising of thick and inconsistent nanoplates. Figure S2c displays the SEM picture of the product using $\text{Na}_2\text{S} \cdot 9\text{H}_2\text{O}$ as the sulfur source. Almost the entire product consists of randomly, aggregated and isolated particles. When thioacetamide was introduced into the reaction system (Figure S2d), growth resulted in the form irregularly aggregated hierarchical architectures comprising of platelets.

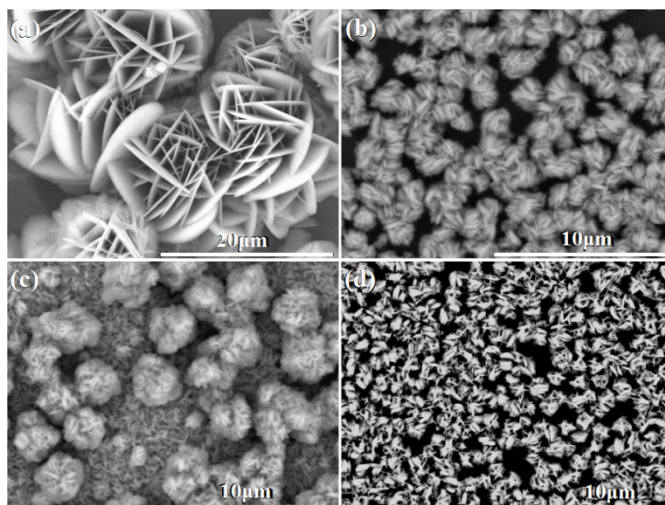


Figure S2. SEM images of the as prepared products using different copper and sulfur sources, under the same typical experimental conditions [180°C, 24hrs] employing different copper and sulfur sources (a) Cupric sulphate ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$), (b) Cupric acetate ($\text{Cu}(\text{CH}_3\text{COO})_2 \cdot 5\text{H}_2\text{O}$), (c) Sodium sulfide ($\text{Na}_2\text{S} \cdot 9\text{H}_2\text{O}$), (d) Thioacetamide (H_3CCSNH_2).

Effect of solvent

Figure S3 depicts the SEM images of the product obtained using different reaction media. Almost hierarchical and aggregated structures have been produced with various sizes and shapes using ethylene diamine (Figure S3a), Diethylene glycol (Figure S3b) and dimethyl formamide (Figure S3c) as solvents. While the product obtained using ethylene glycol + water (1:1) as the reaction medium (Figure S3d), is composed of some of hierarchical architectures and randomly displaced particles with inconsistent shape and size, moreover no reaction could occur when only water was used as the solvent.

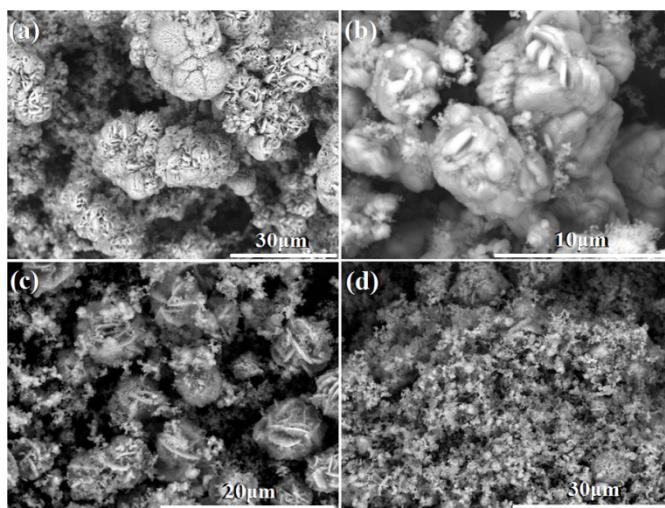


Figure S3. SEM images of the as prepared products using different solvents, under the same typical experimental conditions [$\text{Cu}(\text{NO}_3)_2 \cdot 3\text{H}_2\text{O} = 1\text{mmol}$, sulfur = 2mmol at 180°C for 24hr] (a) Ethylene diamine, (b) Diethylene glycol (DEG), (c) Dimethyl formamide (DMF), (d) Ethylene glycol + Water (1:1).

Effect of temperature

Figure S4 depicts the SEM images of the as prepared products of CuS exhibiting hierarchical morphology at different temperatures, such as, 140°C, 160°C, 180°C, and 200°C under the same typical experimental procedure. Here initial reaction temperature was chosen to be 140°C to exceed the melting point of sulfur (120°C), no reaction occurred at 100°C. At 140°C (Figure S4a), all hierarchical structures are made up of densely packed nanoplates with extremely thin thickness, and irregularly aggregated. At 160°C, all hierarchical microstructures consist of sparsely packed nanoplates and well interconnected with a definite shape and size in a quite regular manner, as shown in Figure S4b. Whereas, it can be seen that CuS hierarchical architectures obtained at 180°C (Figure S4c) are all in well defined and identically arranged nanoplates. Moreover, when the temperature was chosen to be 200°C as shown in Figure S4d, the irregular and shape and size inconsistent hierarchical microstructures were produced. The hierarchical architectures seem to be comprising of thickest nanoplates, moreover some isolated nanoparticles appear to be attached on the surface of these as prepared distorted hierarchical architectures. This distortion in morphology and secondary growth on the entire surface of individual morphology is due to too high temperature.

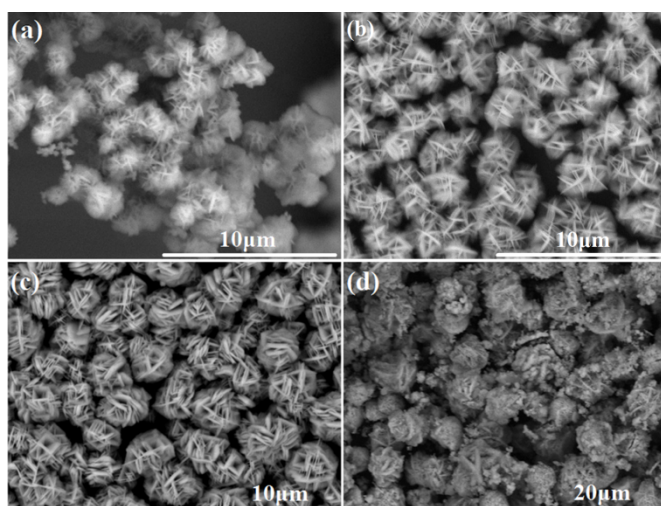


Figure S4. SEM images of the as prepared products at different temperatures, under the same typical experimental conditions [$\text{Cu}(\text{NO}_3)_2 \cdot 3\text{H}_2\text{O} = 1\text{mmol}$, sulfur = 2mmol, ethylene glycol = 40ml for 24hr] (a) 140°C, (b) 160°C, (c) 180°C, (d) 200°C.

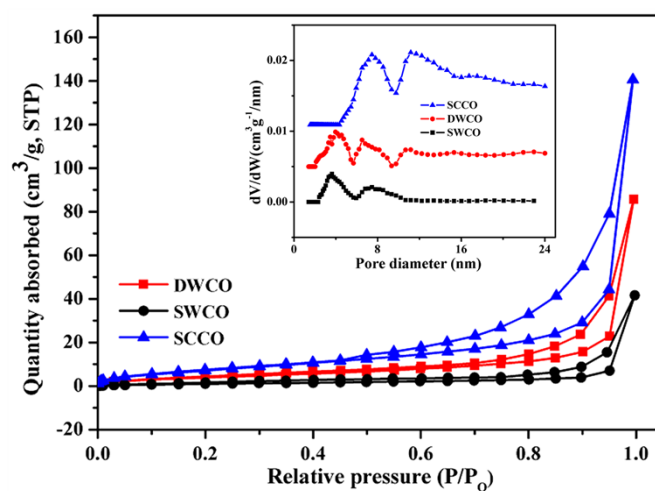


Figure S5. Nitrogen adsorption-desorption isotherms of the as-synthesized CuS products, (inset) pore size distribution curves of as prepared CuS products.

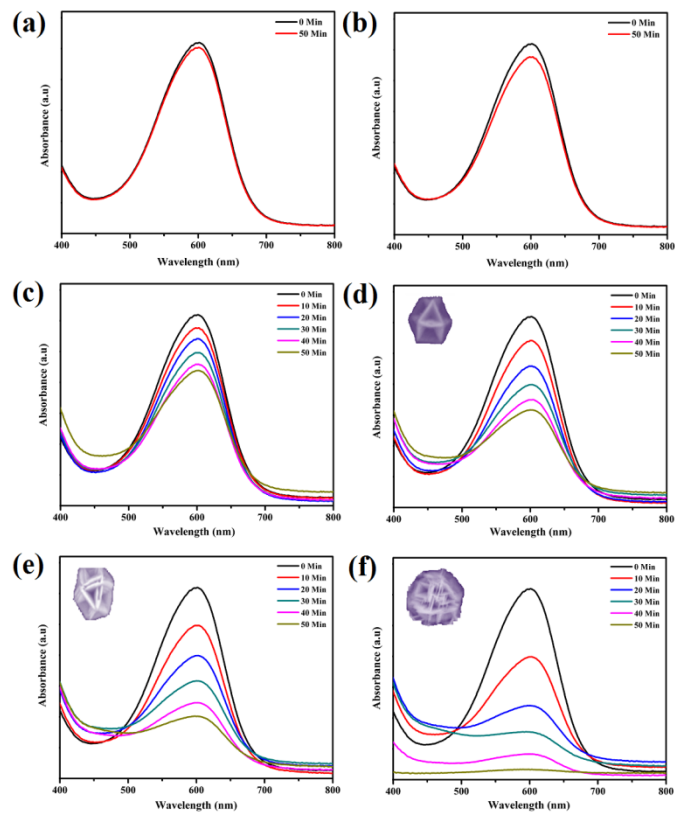


Figure S6. Absorption spectra of photo degradation of MB aqueous solution by different catalysts (20mg) within 50Min of natural light irradiation at room temperature (a) without any catalyst + H_2O_2 , (b) SCCO + no H_2O_2 , (c) commercial CuS powder + H_2O_2 , (d) SWCO + H_2O_2 , (e) DWCO + H_2O_2 , (f) SCCO + H_2O_2 .

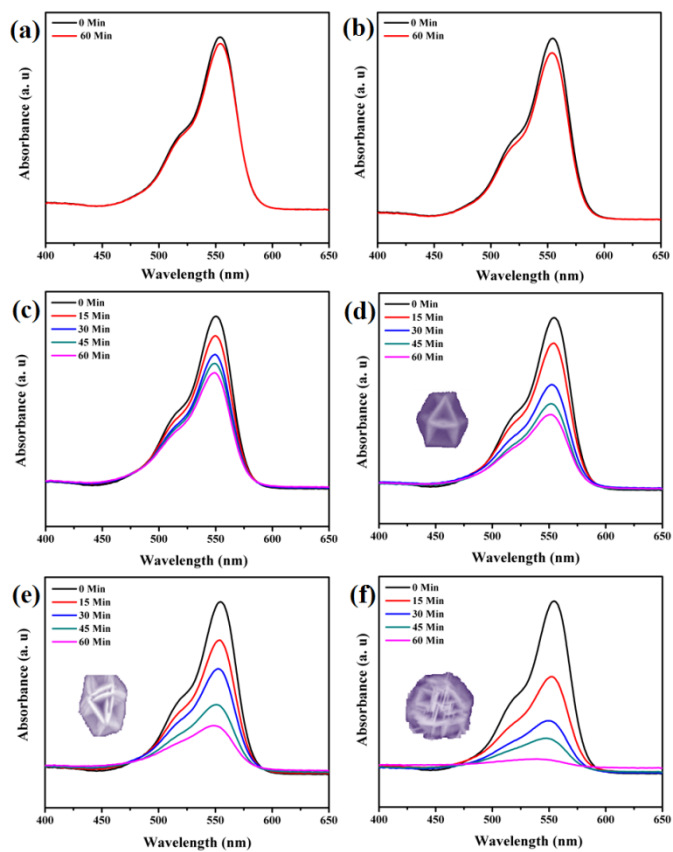


Figure S7. Absorption spectra of photo degradation of RhB aqueous solution by different catalysts (20mg) within 60Min of natural light irradiation at room temperature (a) without any catalyst + H_2O_2 , (b) SCCO + no H_2O_2 , (c) commercial CuS powder + H_2O_2 , (d) SWCO + H_2O_2 , (e) DWCO + H_2O_2 , (f) SCCO + H_2O_2 .

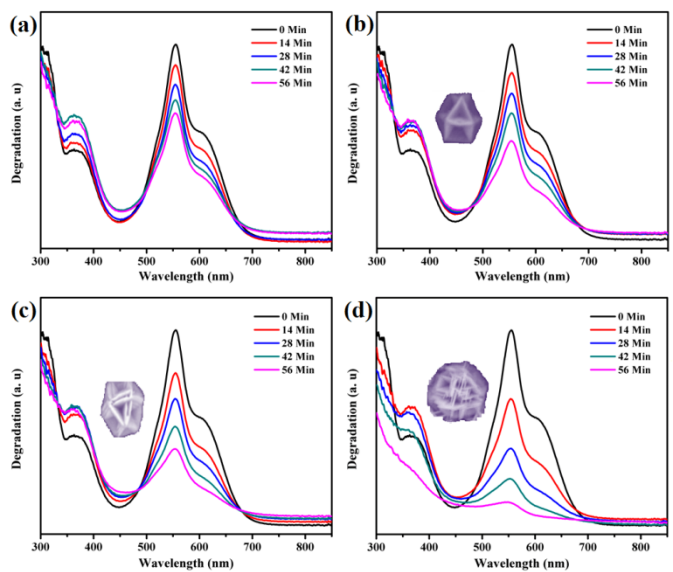


Figure S8. Absorption spectra of photo degradation of mixed dyes (MB+RhB) aqueous solution by different catalysts (20mg) within 56Min of natural light irradiation at room temperature (a) without any catalyst + H_2O_2 , (b) SCCO + no H_2O_2 , (c) commercial CuS powder + H_2O_2 , (d) SWCO + H_2O_2 , (e) DWCO + H_2O_2 , (f) SCCO + H_2O_2 .

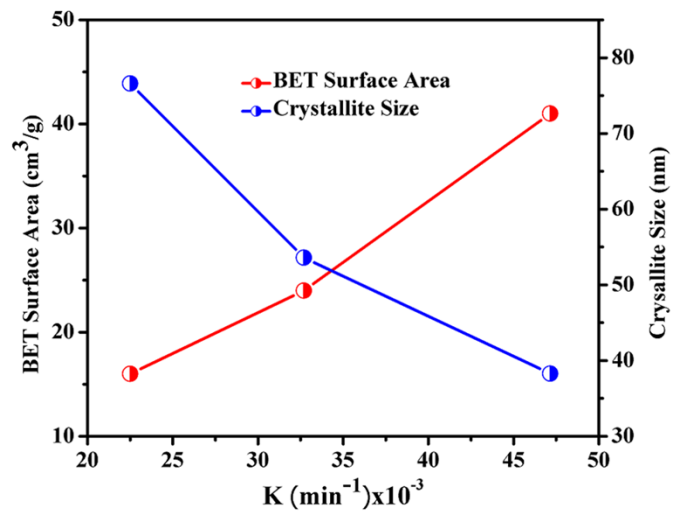


Figure S9. Triplet graph among Crystallite size [SWCO= 76nm, DWCO= 52nm, SCCO= 38nm], BET surface area [SWCO=16 m^2g^{-1} , DWCO=24 m^2g^{-1} , SCCO=41 m^2g^{-1}] and first order rate constant (K/Min) [SWCO=0.02329/min, DWCO= 0.03229/min, SCCO= 0.047247/min] in degrading MB aqueous solution by as synthesized CuS cuboctahedron products.