# Supplementary Materials

# An Investigation of PPy@1T/2H $MoS_2$ Composites with Durable Photothermal-Promoted Effect in Photo-Fenton Degradation of Methylene Blue and in Water Evaporation

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**Figure S1**

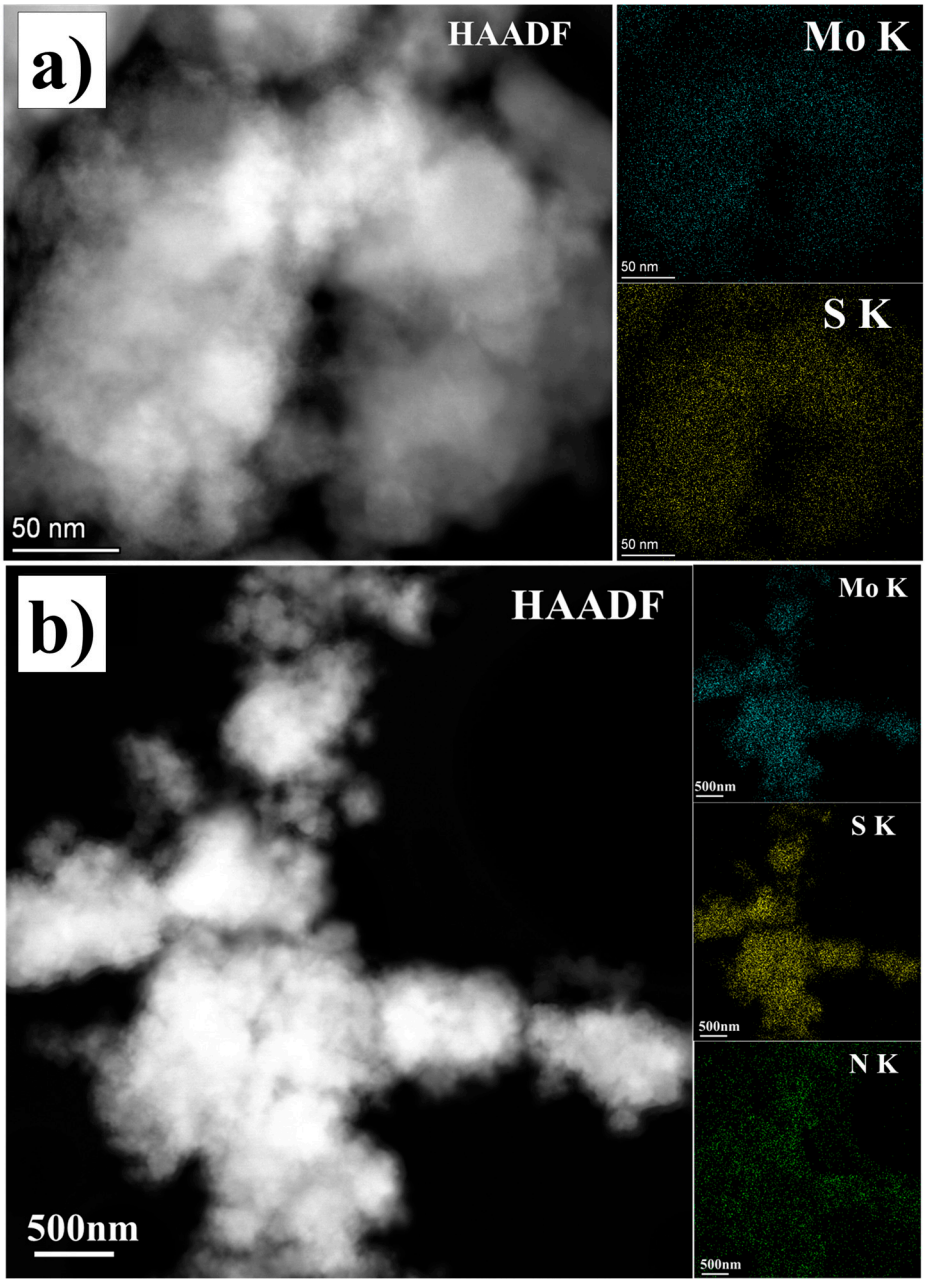


**Figure S1.** HAADF-STEM images and element-mapping images of the magnified branched region in the(a) PPy@1T-2H $MoS_2$ and (b) 1T-2H $MoS_2$ nanospheres.

**Figure S2**

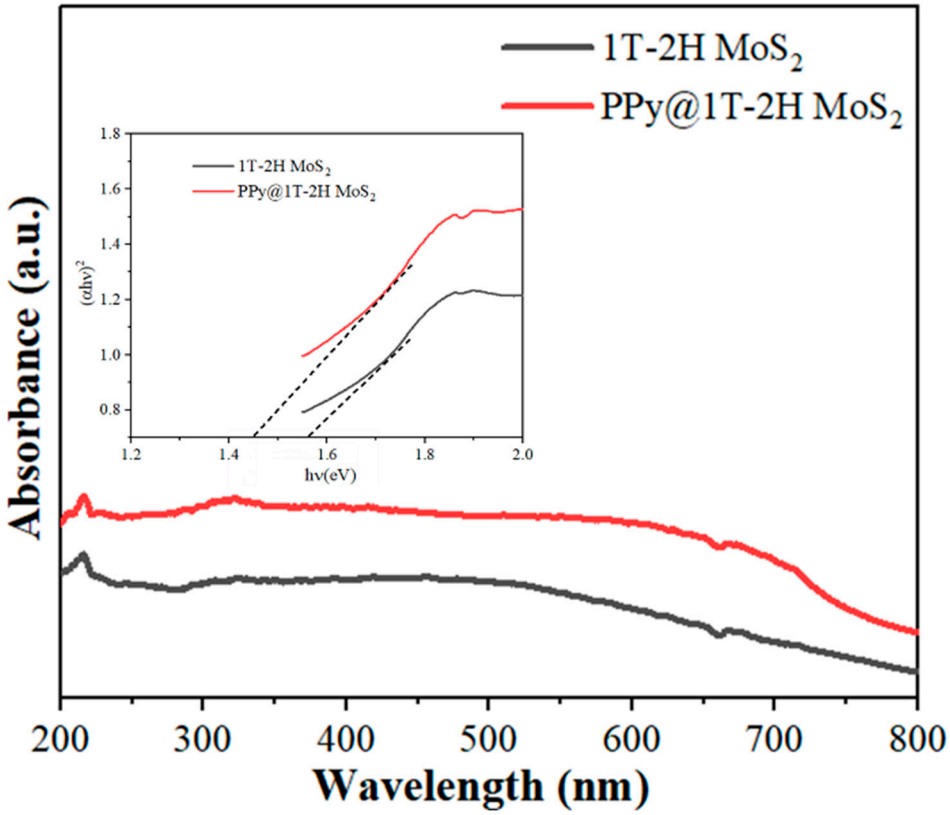


**Figure S2.** UV–vis spectra of PPy@1T-2H $MoS_2$ and 1T-2H $MoS_2$.

**Figure S3**

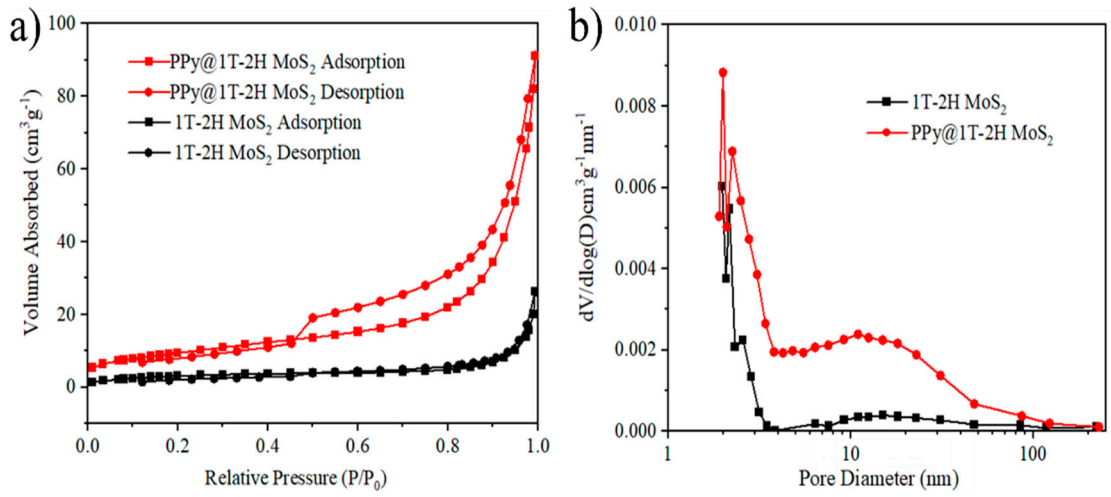


**Figure S3.** (a) Adsorption–desorption isotherms for $N_2$ for PPy@1T-2H $MoS_2$ and 1T-2H $MoS_2$; (b) pore diameter distribution diagram.

**Figure S4**

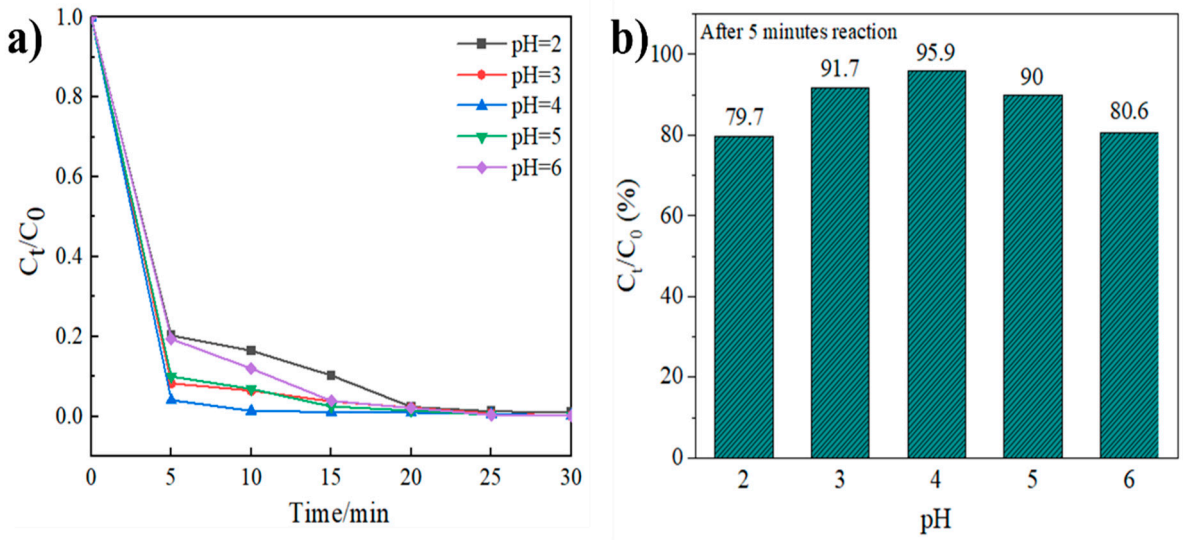


**Figure S4.** (a) Effect of initial pH on the decolorization of MB by Fenton oxidation; (b) degradation efficiency of the reaction for 5 min. The experimental conditions were 50 mg PPy@1T-2H $MoS_2$ catalyst, 5 mg of $FeSO_4$, and 500 µL of $H_2O_2$ in 200 mL of contaminated water ([MB] = 25 mg/L).

**Figure S5**

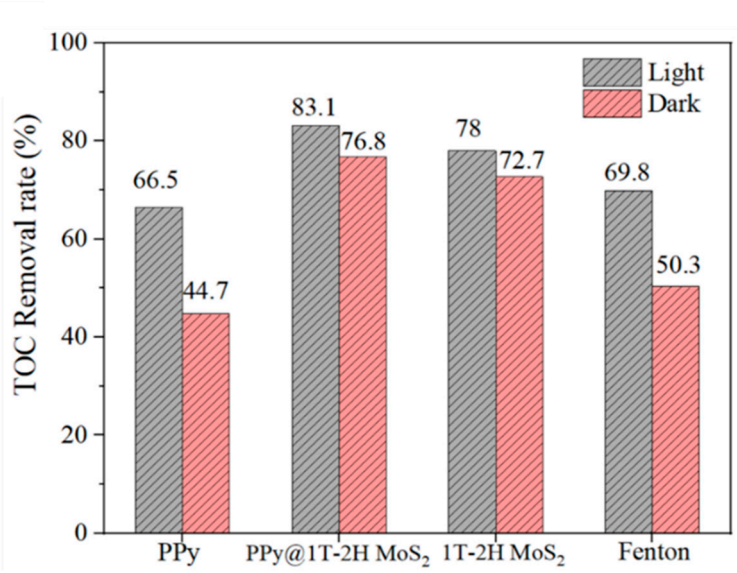


**Figure S5** TOC analysis of MB in photocatalytic degradation process by the traditional Fenton method, pure PPy, 1T-2H $MoS_2$, and PPy@1T-2H $MoS_2$ catalysts. The experimental conditions consisted of 50 mg of catalyst, 5 mg of $FeSO_4$, and 500 μL of $H_2O_2$ in 200 mL of contaminated water ([MB] = 25 mg/L).

**Figure S6**

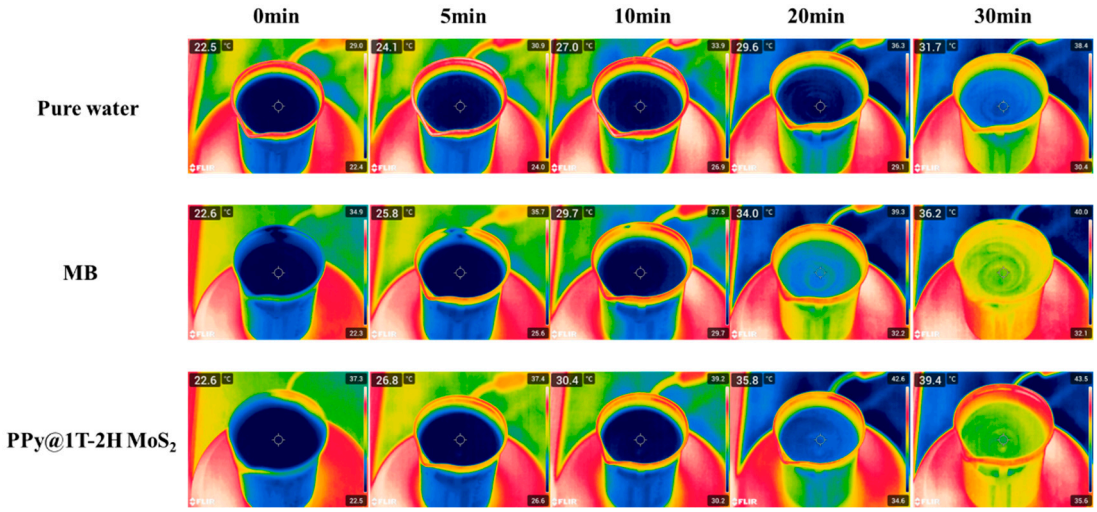


**Figure S6** IR images of the temperature change of the upper surface of Water, MB and PPy@1T-2H $MoS_2$+MB system in 30 minutes.

**Figure S7**

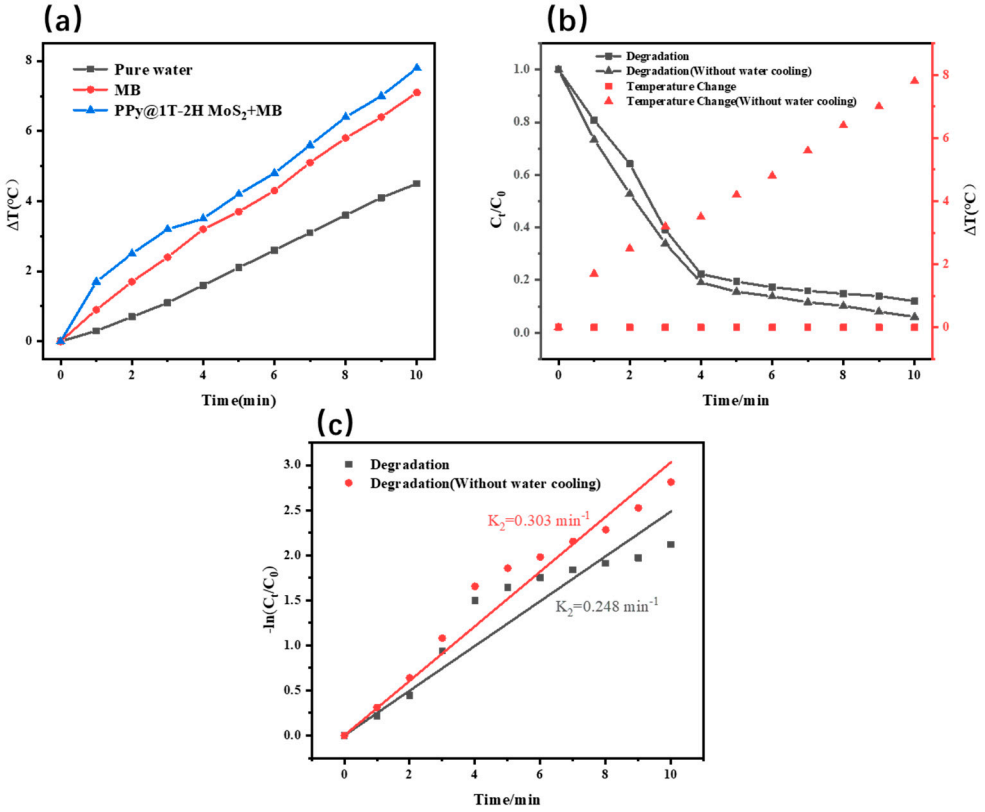


Figure S7 (a) Photothermal heating curves of the pure water, MB-containing water, and PPy@1T-2H $MoS_2$+MB containing water. (b) Relative concentration changes ($C_t/C_0$) of MB and Photothermal heating curves of the PPy@1T-2H $MoS_2$ with and without temperature control. (c) The kinetic fit for MB degradation by PPy@1T-2H $MoS_2$ composites at various temperatures.

Figure S8

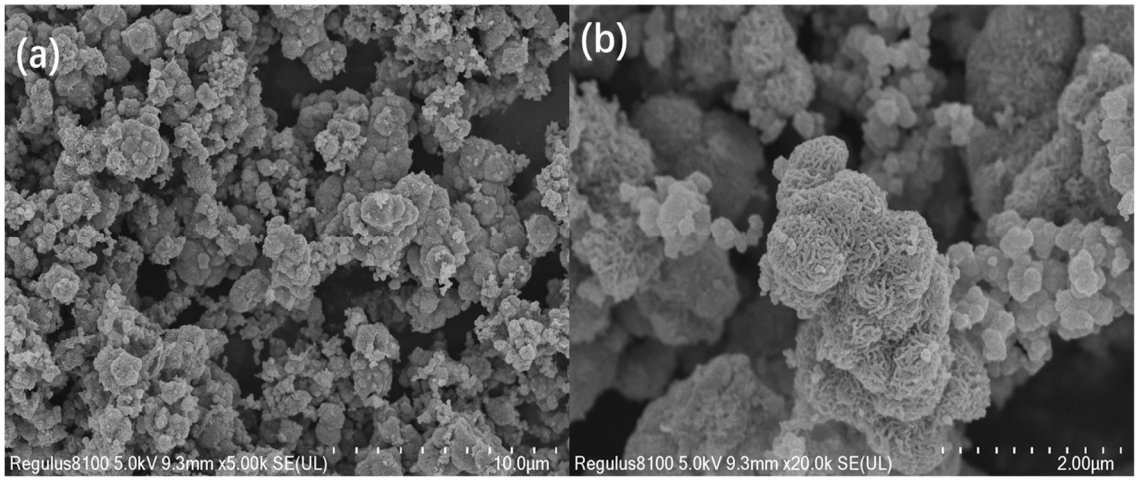


Figure S8 The SEM morphology of the PPy@1T-2H MoS2 after the 5th cyclic test.

Figure S8 shows the morphology of the PPy@1T-2H $MoS_2$ after the 5th cyclic testament. A spherical morphology was observed. And the composites are consisted of aggregated PPy coated nanosheets. It can be observed that the cyclic measurement did not alter the morphology of PPy@1T-2H $MoS_2$, indicating the structure stability of the composites.

Figure S9

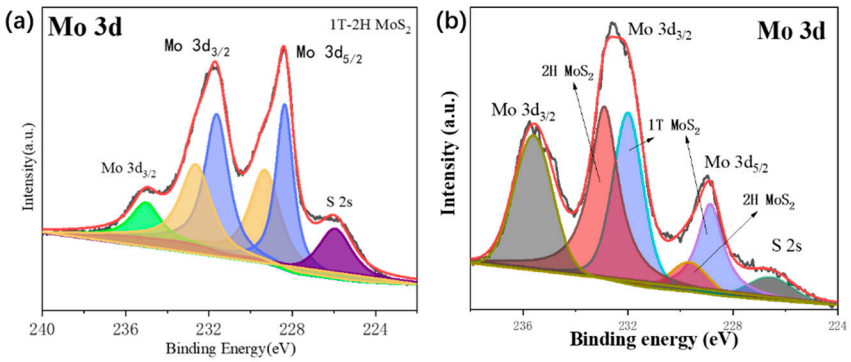


Figure S9. The Mo 3d XPS spectrum of 1T-2H MoS2 (a) before the first test and (b) after the 5th cyclitic test.

The Mo 3d XPS spectrum of 1T-2H MoS2 after 5th cyclitic test of the 1T-2H MoS2 is given in Figure S9(b), in which six peaks were divided in Mo 3d. Among the peaks, the peaks located at 231.9, 228.9, 232.7, and 229.7 eV, corresponding to $Mo^{4+}$, and 3d3/2 and 3d5/2 in the 1T phase, and $Mo^{4+}$, 3d3/2 and 3d5/2 in the 2H phase. The peak at 225.3 eV is associated with the S 2s of the unsaturated sulfur atoms in $MoS_2$, and the peak located at 235.4 eV might be associated with Mo(VI) $3d_{3/2}$, which may be the result of the partial oxidation of $MoS_2$ to $MoO_3$. When we compared to the Mo 3d XPS spectrum in Fig. S9, it was observed that the shape of the spectra changed significantly, indicating the changes of the1T-2H MoS2 during cyclic measurement. The intensity of the peak observed at 232.7 eV obvious enhanced, while the decrease of the peak at 231.9 eV, which indicated a decrease in the phase of the 1T component and an increase in the 2H phase. We compared the compositional changes of 1T and 2H phases in $MoS_2$ samples before the first and after 5 cycles test of the 1T-2H $MoS_2$ and PPy@1T-2H $MoS_2$ catalysts by integrating the peaks of the corresponding 2H and 1T phases in the XPS plain. The results were summarized in Table S2.

Table S1

Table S1: Sample elemental composition weight percent ratio.

| | 1T-2H $MoS_2$ | PPy@1T-2H $MoS_2$ |
|---|---|---|
| C | 14.8% | 27.5% |
| O | 9.7% | 5.3% |
| S | 22.9% | 17.4% |
| Mo | 52.6% | 45.3% |
| N | | 4.4% |

Table S2

Table S2: Changes in the quantization ratio of 2H to 1T phase in1T-2H $MoS_2$ during the cyclitic test.

| | *2H phase* | | *1Tphase* | |
|---|---|---|---|---|
| *Cyclic number* | 0 th | 5 th | 0 th | 5 th |
| *1T-2H $MoS_2$* | 38.3% | 61% | 61.7% | 39% |
| *PPy@1T-2H $MoS_2$* | 38.2% | 45.2% | 61.8% | 54.8% |