# Support Materials

## Sulfur Vacancy on $MoS_2$ Enhanced the Activation of Peroxymonosulfate through the Co-existence of Radical and Non-radical Pathways to Degrade Organic Pollutants in Wastewater

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# Figure S1

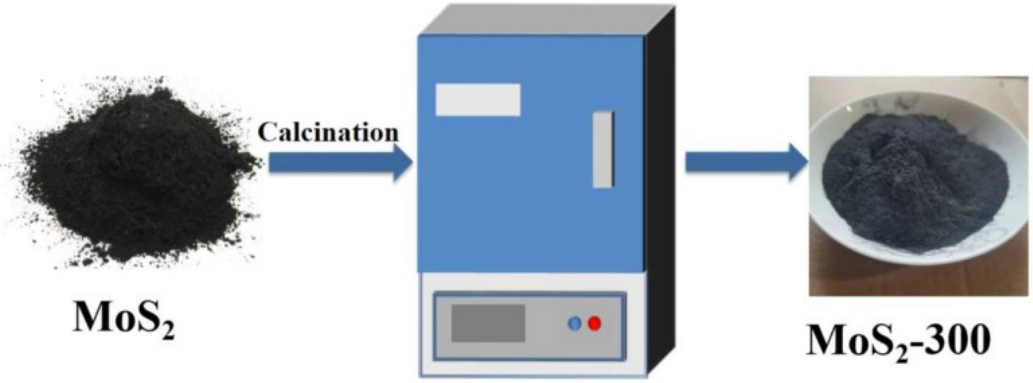


**Figure S1** Preparation step of $MoS_2$-300 catalyst.

# Figure S2

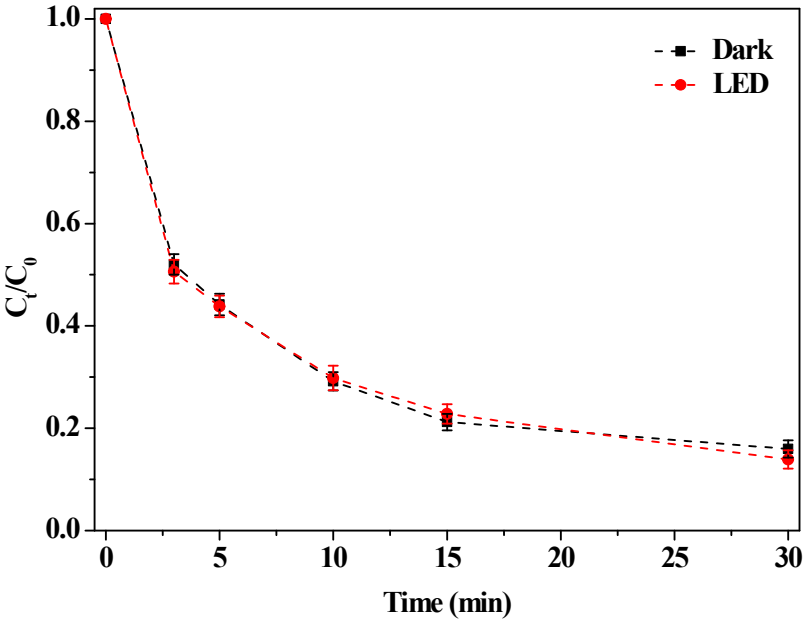


**Figure S2** Comparison of darkness and LED illumination on degradation of RhB. Reaction conditions: [RhB] = 10 mg/L, [PMS] = 1.0 mM, [$MoS_2$-300] = 1.0 g/L, initial pH = 3.0.

# Figure S3

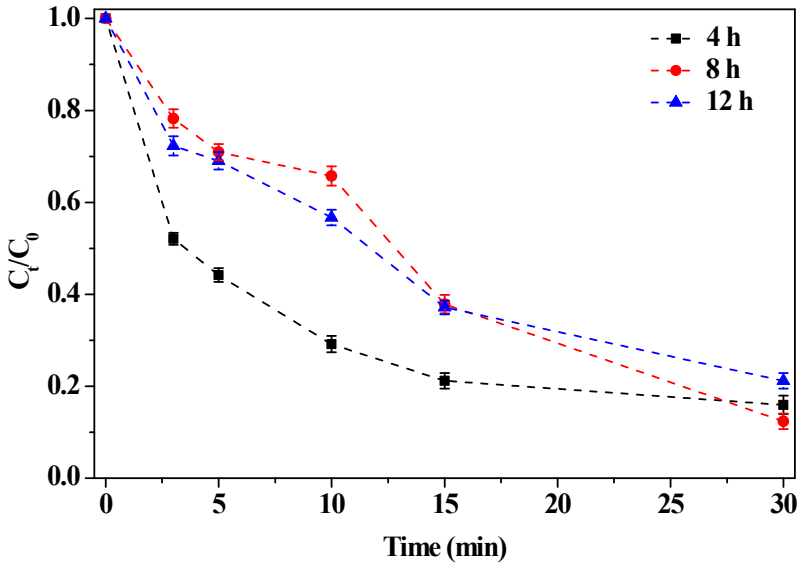


**Figure S3** Effect of the treated time on the degradation of RhB. Reaction conditions: [RhB] = 10 mg/L, [PMS] = 1.0 mM, [$MoS_2$-300] = 1.0 g/L, initial pH = 3.0, in the darkness.

# Figure S4

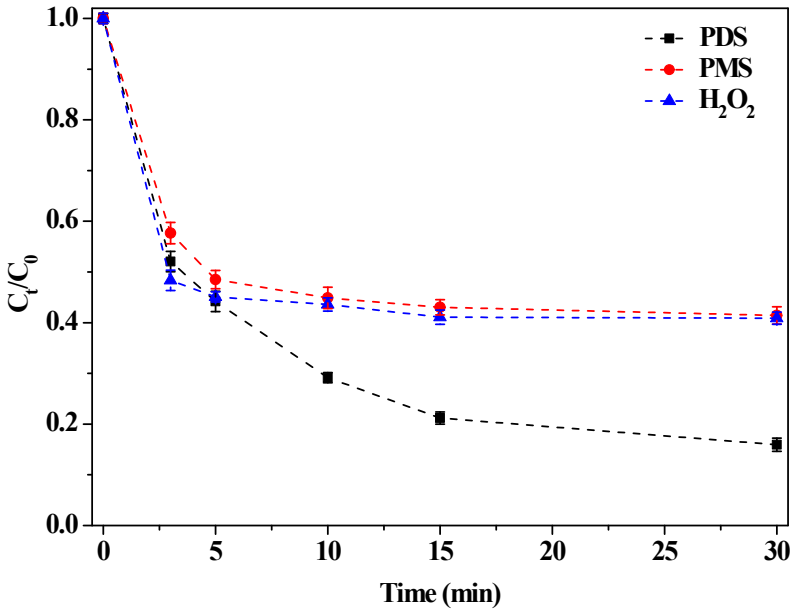


**Figure S4** Removal of RhB with different oxidation system. Reaction conditions: [RhB] = 10 mg/L, [Oxidants] = 1.0 mM, [$MoS_2$-300] = 1.0 g/L, initial pH = 3.0, in the darkness.

# Figure S5

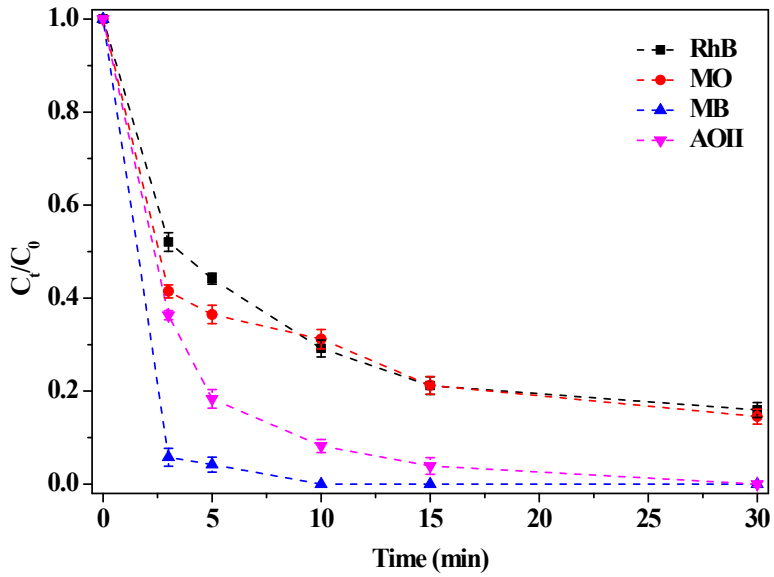


**Figure S5** Removal of organic pollutants. Reaction conditions: [Pollutants] = 10 mg/L, [$MoS_2$-300] = 1.0 g/L, [PMS] = 1.0 mM, initial pH = 3.0, in the darkness.

# Figure S6

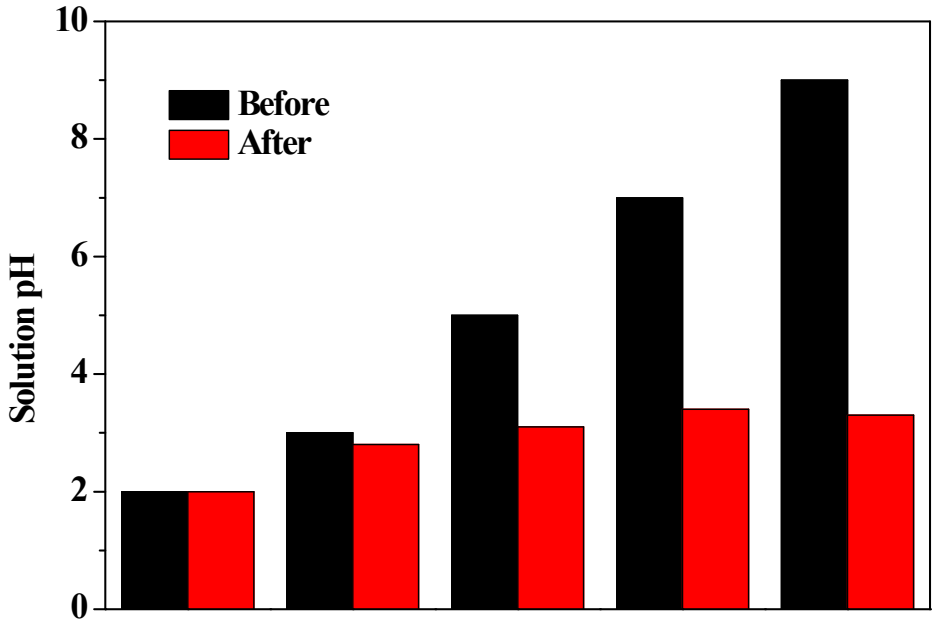


**Figure S6** Changes of solution pH before and after the reaction.

# Figure S7

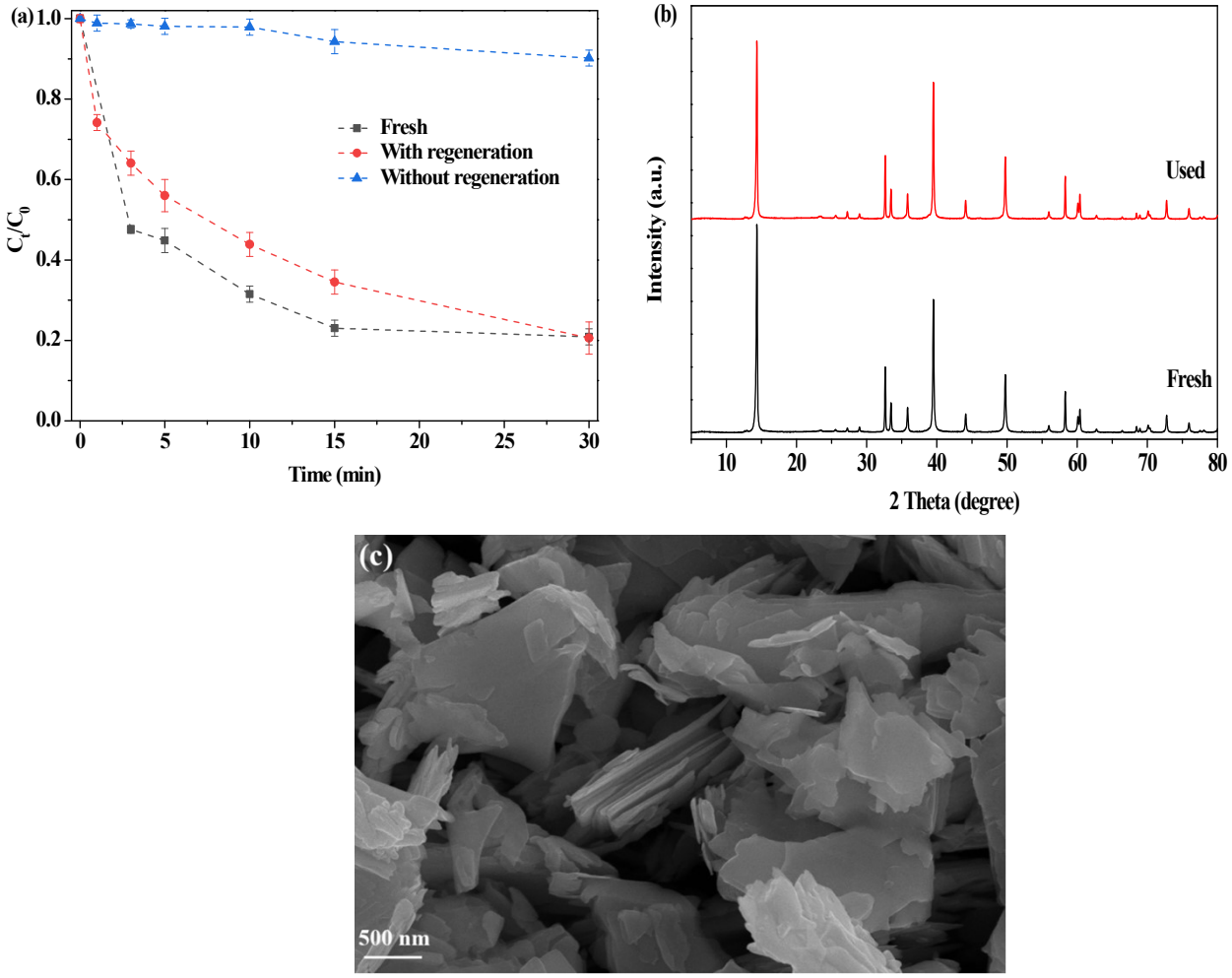


**Figure S7** (a) Removal of RhB without or with regeneration; (b) XRD patterns of fresh and used $MoS_2$ catalysts; (c) SEM image of used $MoS_2$-300 catalyst. Reaction conditions: [RhB] = 10 mg/L, [PMS] = 0.5 mM, [$MoS_2$-300] = 1.0 g/L, initial pH = 3.0, in the darkness.

# Figure S8

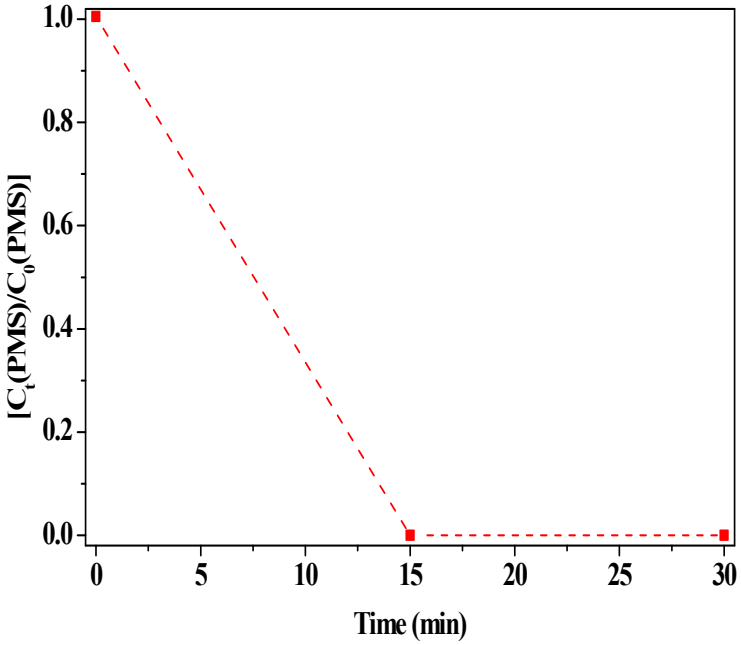


**Figure S8** Decomposition of PMS. Reaction conditions: [RhB] = 10 mg/L, [$MoS_2$-300] = 1.0 g/L, [PMS] = 1.0 mM, initial pH = 3.0, in the darkness.

**Table S1** Changes of surface Mo(IV) concentration, ratios of Mo(IV) and Mo(VI), and 2H-$MoS_2$ and 1T-$MoS_2$ phases in catalysts with different temperatures by XPS characterization [a].

| Catalysts | Mo(IV) | Mo(IV)/Mo(VI) | 2H-$MoS_2$/1T-$MoS_2$ [b] | 2H-$MoS_2$/1T-$MoS_2$ [c] |
|---|---|---|---|---|
| $MoS_2$ | 98.3% | 57.8 | 0.48 | 0.50 |
| $MoS_2$-300 | 85.1% | 5.7 | 0.62 | 0.66 |
| $MoS_2$-500 | 58.8% | 1.4 | 0.28 | no |

[a] : Based on the peak area of each component; [b] : Mo 3d; [c] : S 2p.

**Table S2** The concentrations of detected elements in reaction solution after the fifth reaction by ICP-MS.

| Catalysts | Mo (mg/L) | S (mg/L) |
|---|---|---|
| $MoS_2$-300 | 36.2 | 91.6 |