

# Electron-Rich Triazine-Conjugated Microporous Polymers for the Removal of Dyes from Wastewater

Bao-Ning Li <sup>1,\*†</sup>, Xing-Long Zhang <sup>1,†</sup>, Xiao-Hui Bai <sup>1,†</sup>, Zhen-Jie Liang <sup>2</sup>, Jian Li <sup>1</sup> and Xiao-Yong Fan <sup>1</sup>

<sup>1</sup> School of Chemistry and Chemical Engineering, Yulin University, Yulin 719000, China;

lbningyl@163.com (X.-L.Z.); bxh0727@163.com (X.-H.B.); lijian5220@163.com (J.L.);

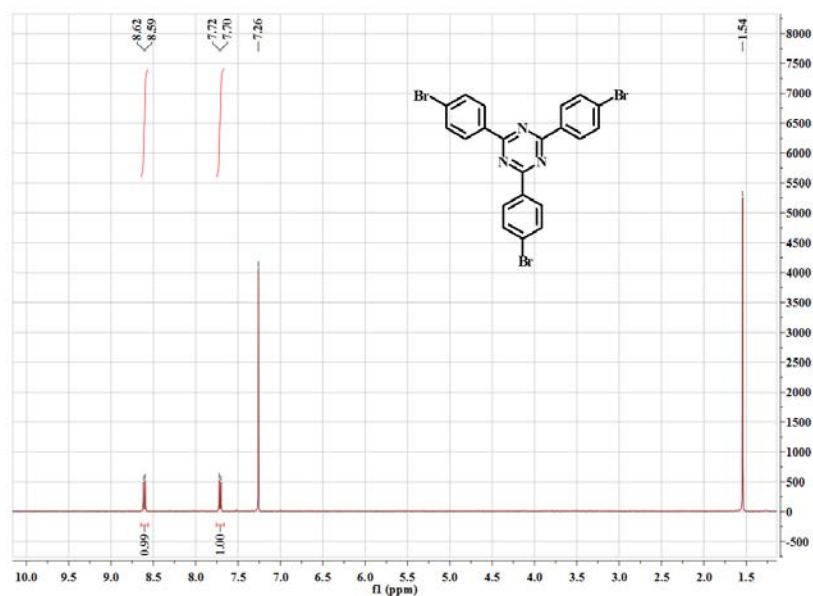
fanxy@yulinu.edu.cn (X.-Y.F.)

<sup>2</sup> School of Chemistry, Sun Yat-Sen University, Guangzhou 510006, China;

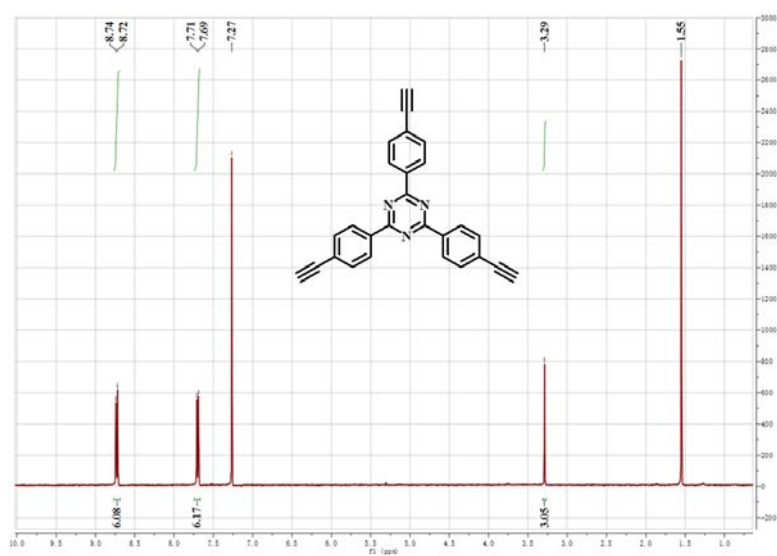
liangzhj9@mail2.sysu.edu.cn

\* Correspondence: lbning@yulinu.edu.cn

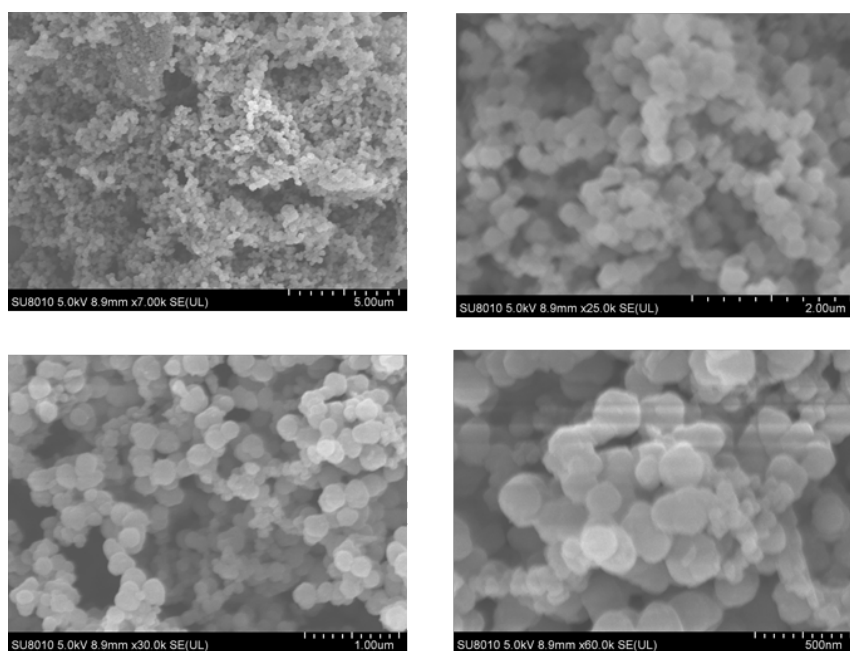
† These authors contributed equally.



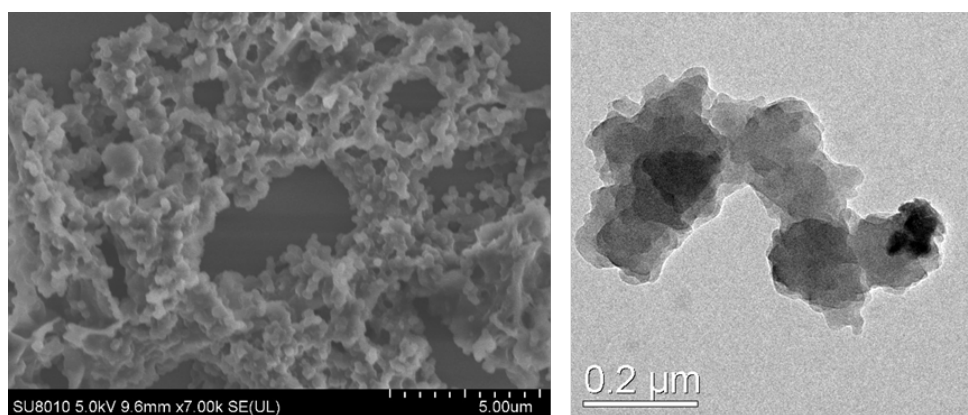
**Figure S1.**  $^1\text{H}$ -NMR spectrum of TBPT, (400 MHz,  $\text{CDCl}_3$ , TMS):  $\delta$  (ppm) 8.58 (d, 6H), 7.69 (d, 6H).



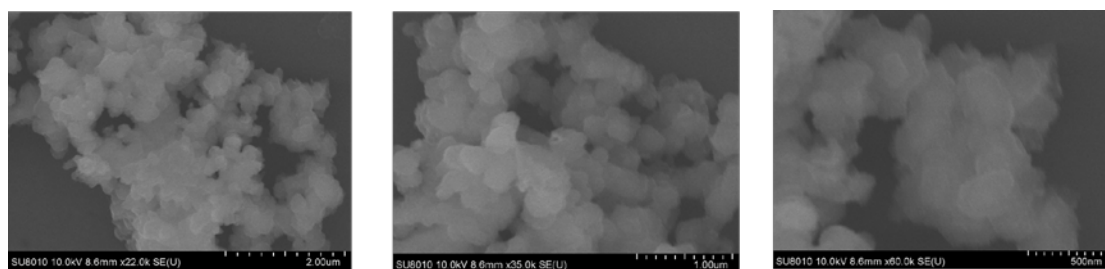
**Figure S2.**  $^1\text{H}$ -NMR spectrum of TEPT, (400 MHz,  $\text{CDCl}_3$ , TMS):  $\delta$  (ppm) 8.73 (d, 6H), 7.70 (d, 6H), 3.29 (s, 3H).



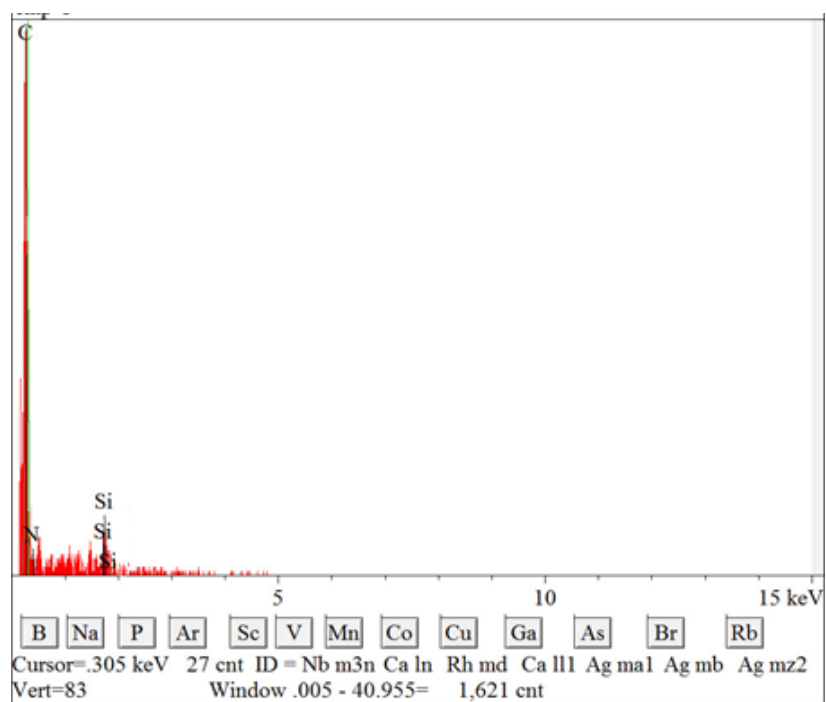
**Figure S3.** SEM-images of T-CMP with different size.



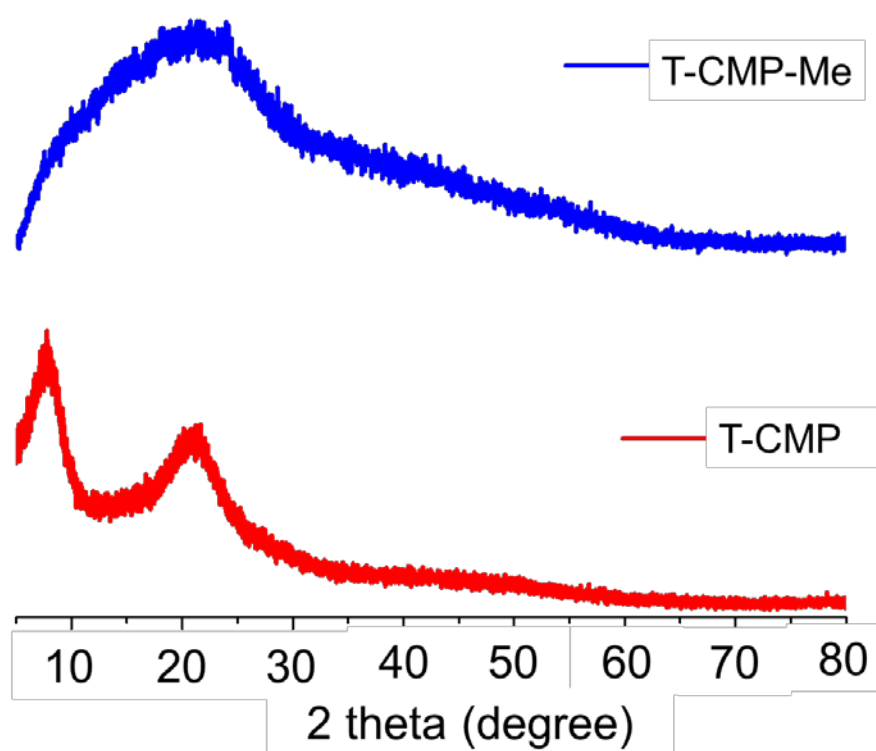
**Figure S4.** SEM and TEM images of T-CMP-Me.



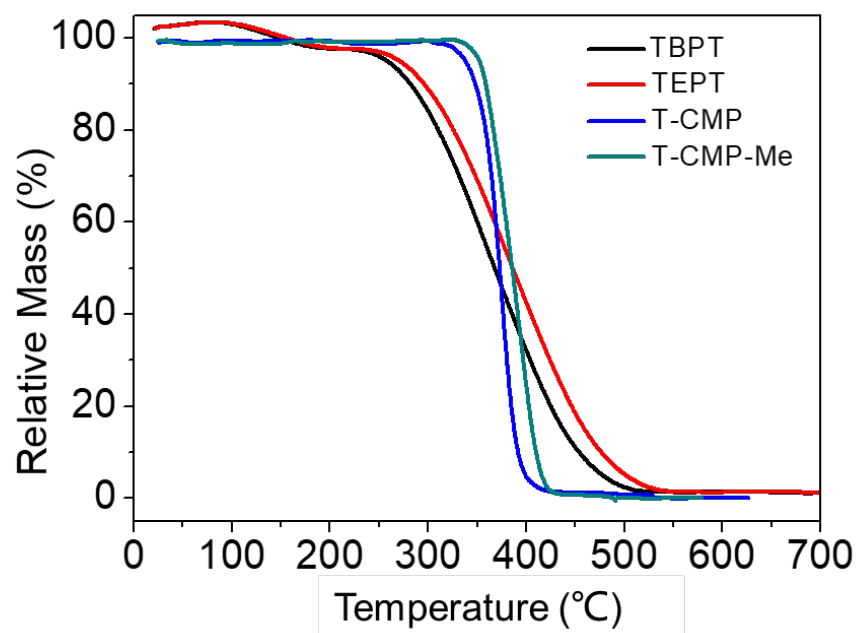
**Figure S5.** SEM images of T-CMP-Me with different size.



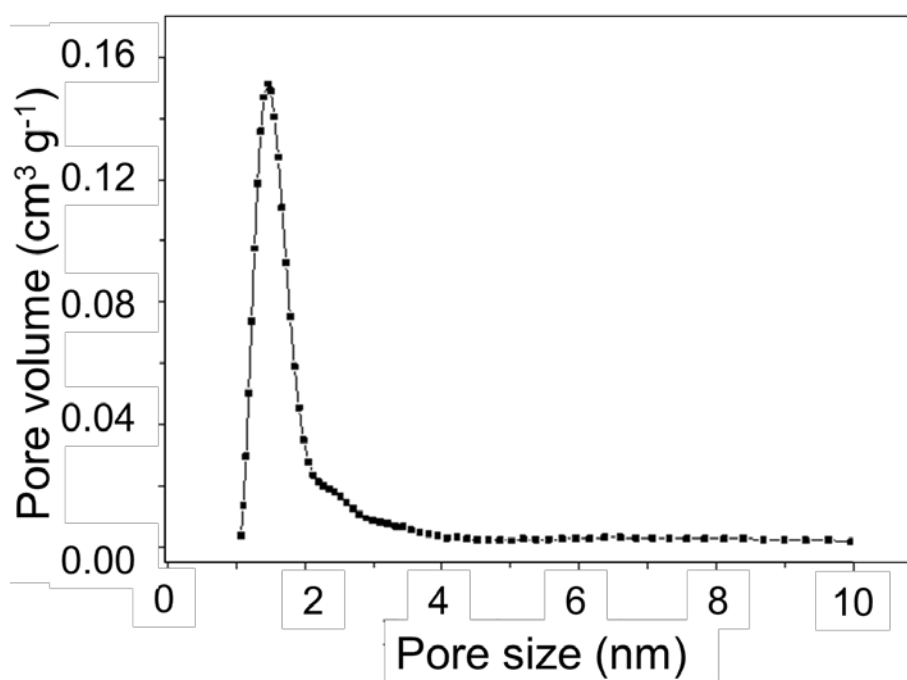
**Figure S6.** Energy-image of T-CMP.



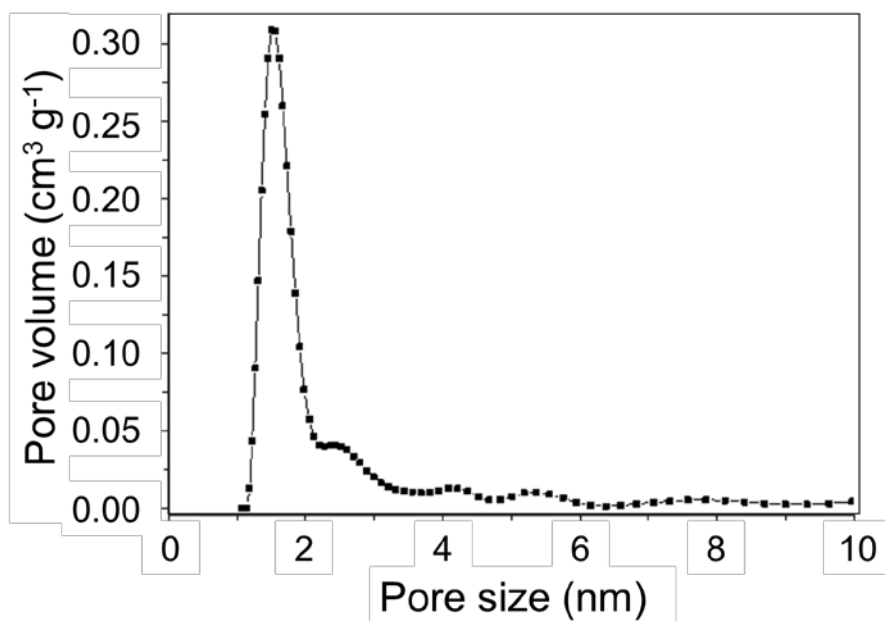
**Figure S7.** Powder x-ray diffraction spectrum of T-CMP and T-CMP-Me.



**Figure S8.** The TG-Curves of the molecules TBPT and TEPT, also compared with the porous materials T-CMP and T-CMP-Me.

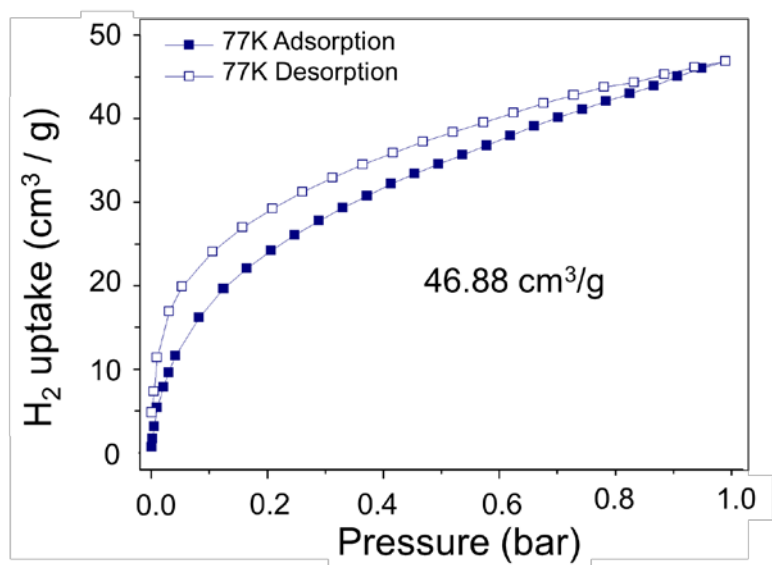


**Figure S9.** The pore size distribution obtained by the NLDFT method of T-CMP.

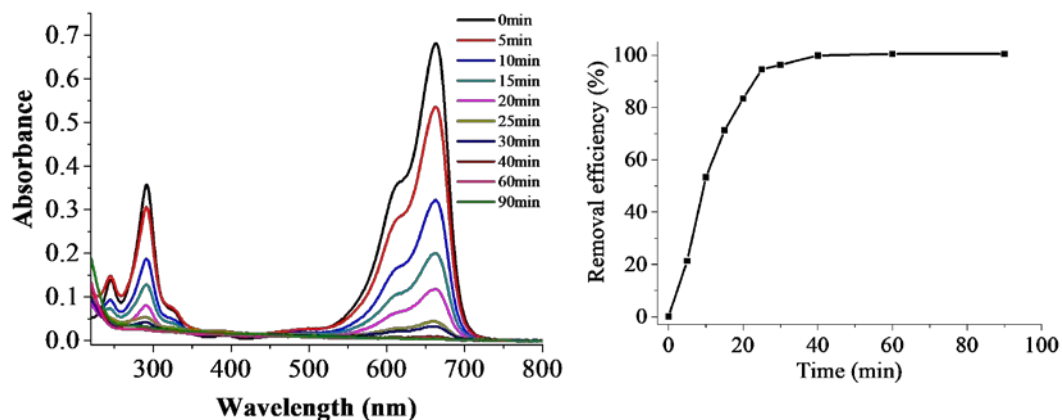


**Figure S10.** The pore size distribution obtained by the NLDFT method of T-CMP-

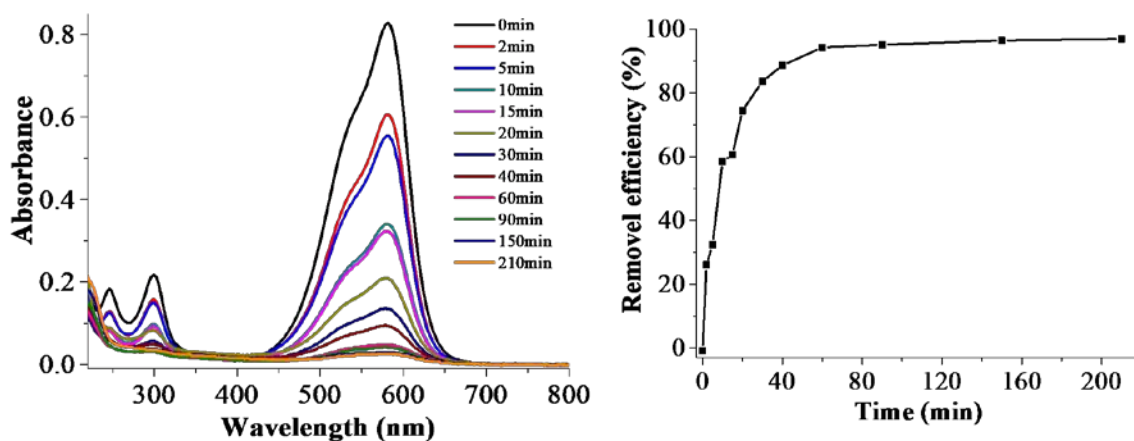
Me.



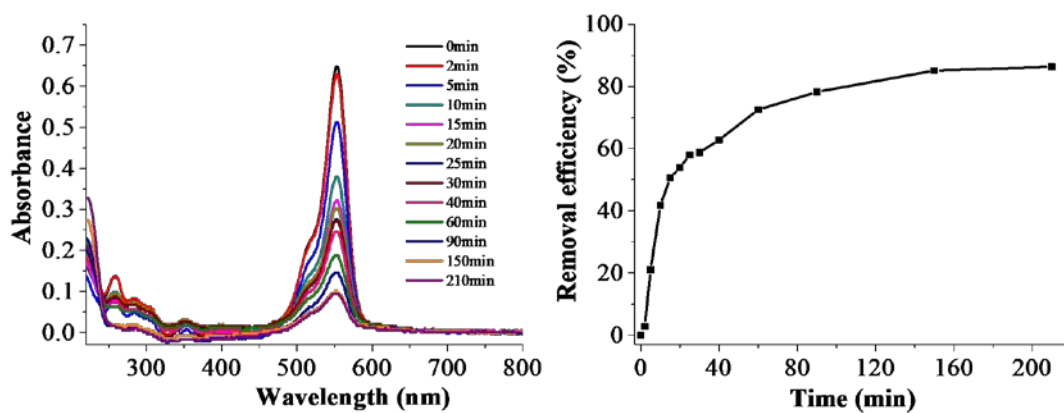
**Figure S11.**  $\text{H}_2$  adsorption–desorption isotherms (77 K) of T-CMP.



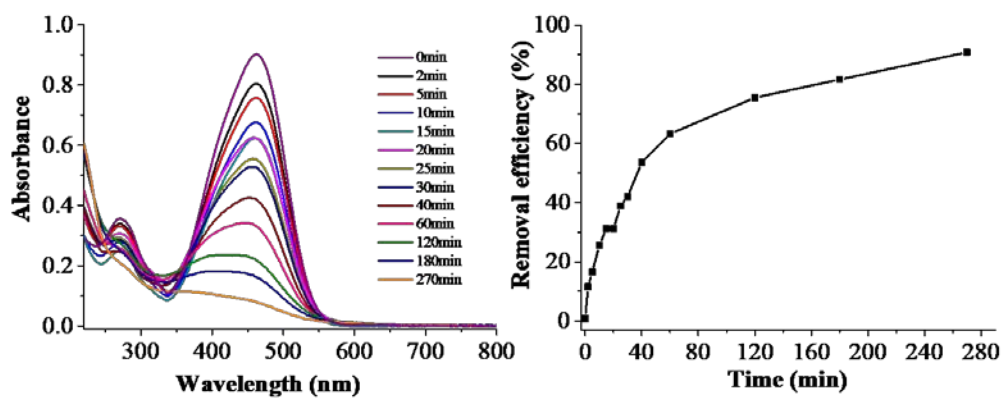
**Figure S12.** Time-dependent adsorption study of (20 mg/L<sup>-1</sup> for each kind of MB<sup>+</sup> dyes, in 20 mL) aqueous solution for T-CMP-Me (3 mg).



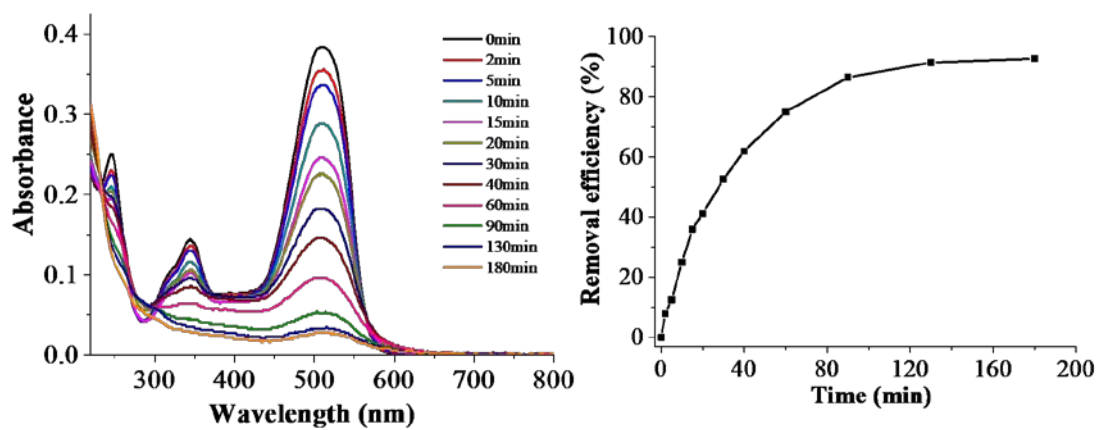
**Figure S13.** Time-dependent adsorption study of (20 mg/L<sup>-1</sup> for each kind of CV<sup>+</sup> dyes, in 20 mL) aqueous solution for T-CMP-Me (3 mg).



**Figure S14.** Time-dependent adsorption study of (20 mg/L<sup>-1</sup> for each kind of RB<sup>+</sup> dyes, in 20 mL) aqueous solution for T-CMP-Me (3 mg).

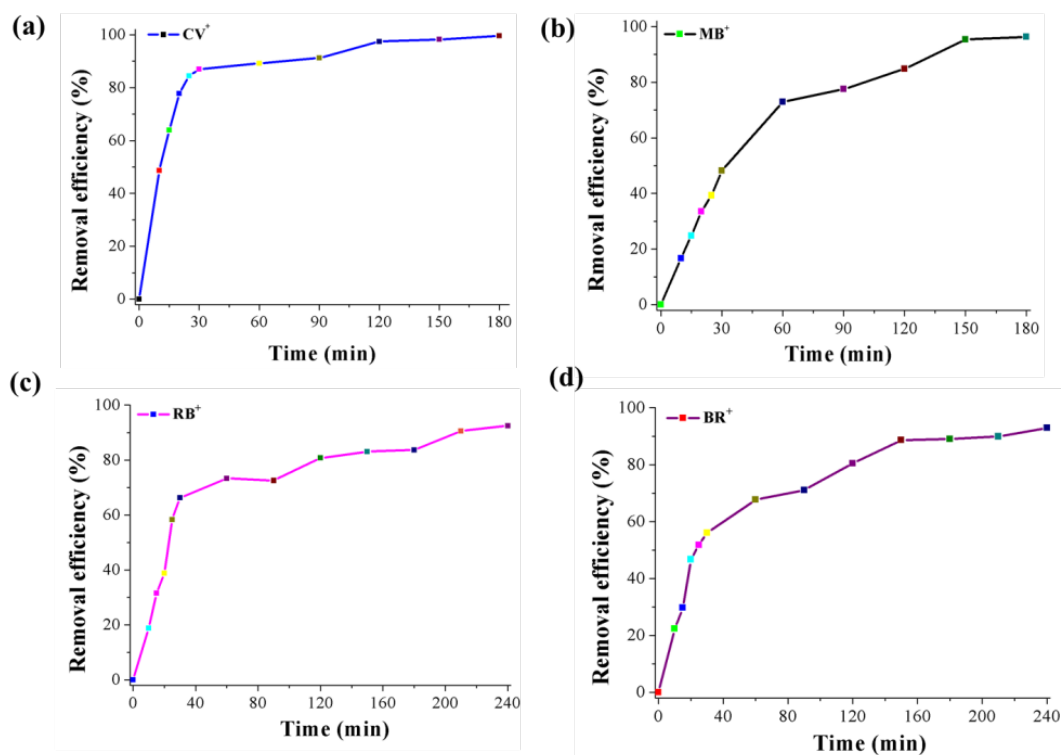


**Figure S15.** Time-dependent adsorption study of ( $20 \text{ mg/L}^{-1}$  for each kind of MO dyes, in 20 mL) aqueous solution for T-CMP-Me (3 mg)

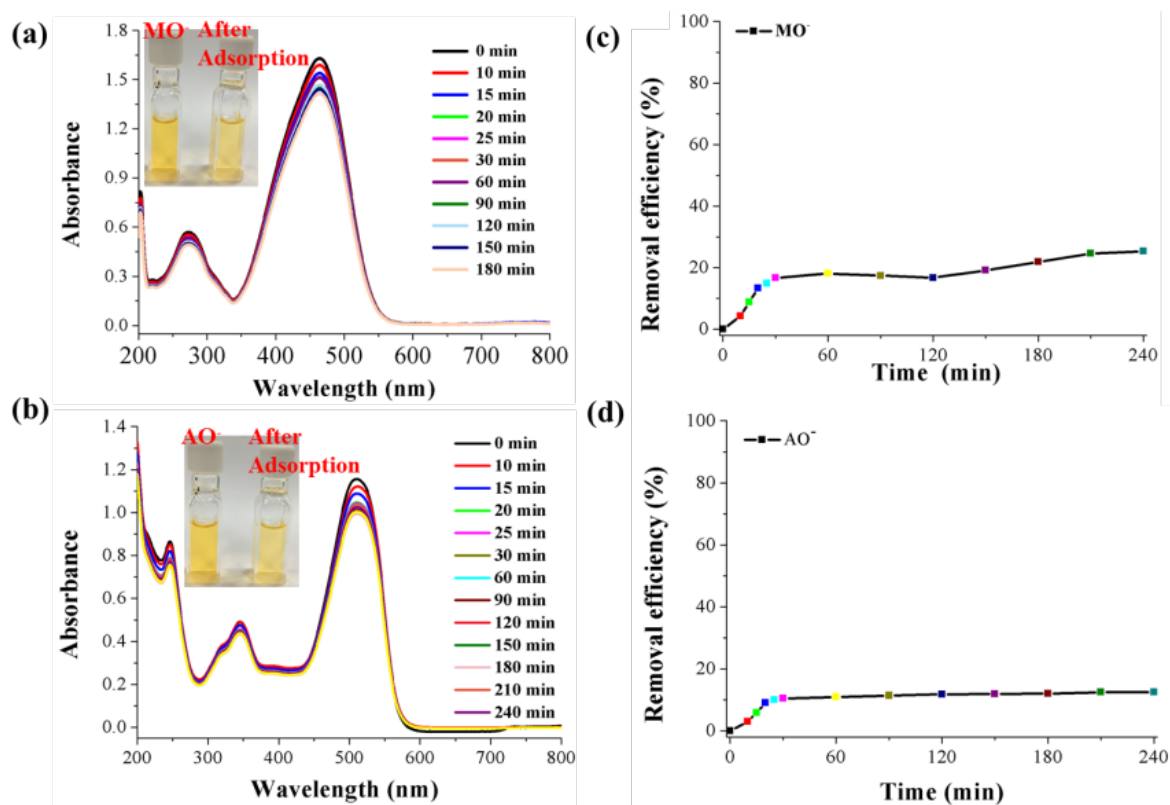


**Figure S16.** Time-dependent adsorption study of ( $20 \text{ mg/L}^{-1}$  for each kind of AO dyes, in 20 mL) aqueous solution for T-CMP-Me (3 mg).

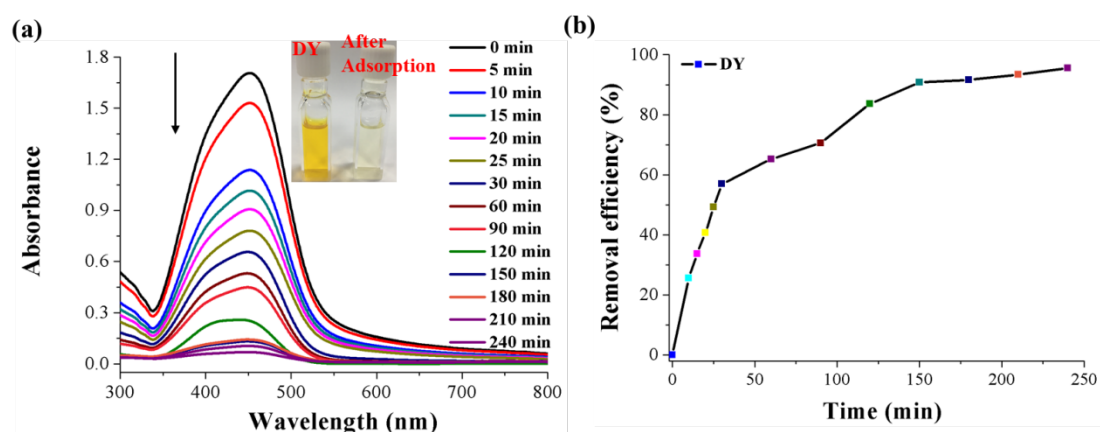




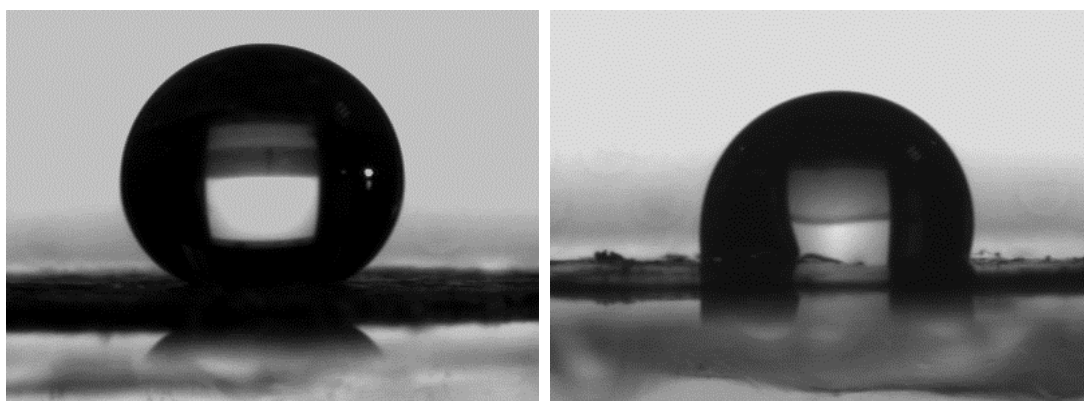
**Figure S17.** The removal efficiency of each mixture aqueous: (a)  $CV^+$ , (b)  $MB^+$ , (c)  $RB^+$ , (d)  $BR^+$ . (Removal efficiency =  $\frac{C_0 - C_t}{C_0} \times 100\%$ ,  $C_0$ : the original concentration;  $C_t$ : the concentration at the moment t).



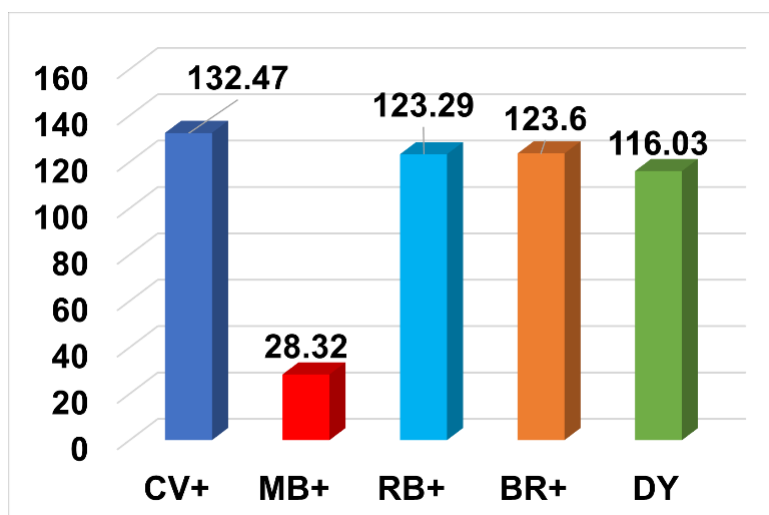
**Figure S18.** Time-dependent adsorption study of ( $20 \text{ mg/L}^{-1}$  for anionic-dyes, in 20 mL) aqueous solution: (a)  $\text{MO}^-$ , (b)  $\text{AO}^-$ . The removal efficiency of anionic dyes: (c)  $\text{MO}^-$ , (d)  $\text{AO}^-$ . (Removal efficiency =  $(C_0 - C_t)/C_0 \times 100\%$ ,  $C_0$ : the original concentration;  $C_t$ : the concentration at the moment  $t$ ).



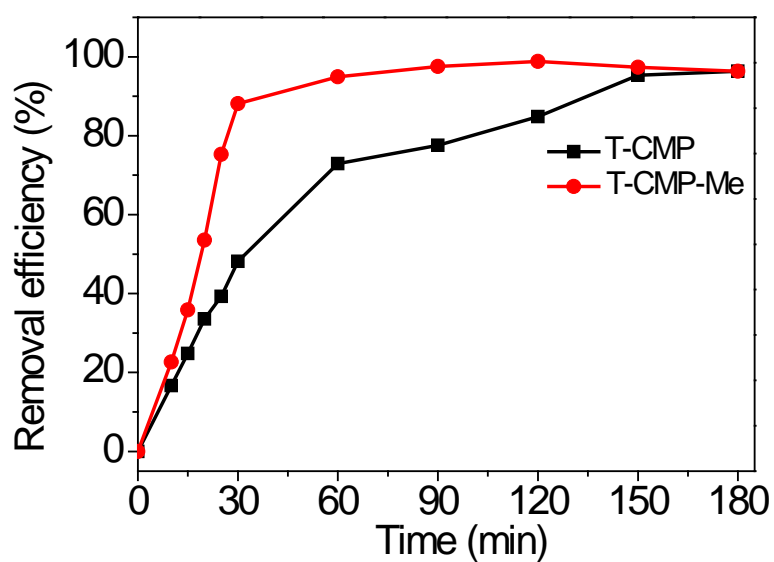
**Figure S19.** Time-dependent adsorption study of ( $20 \text{ mg/L}^{-1}$  for neutral-dye, in 20 mL) aqueous solution: (a) DY. The removal efficiency of anionic dyes: (b) DY. (Removal efficiency =  $(C_0 - C_t)/C_0 \times 100\%$ ,  $C_0$ : the original concentration;  $C_t$ : the concentration at the moment  $t$ ).



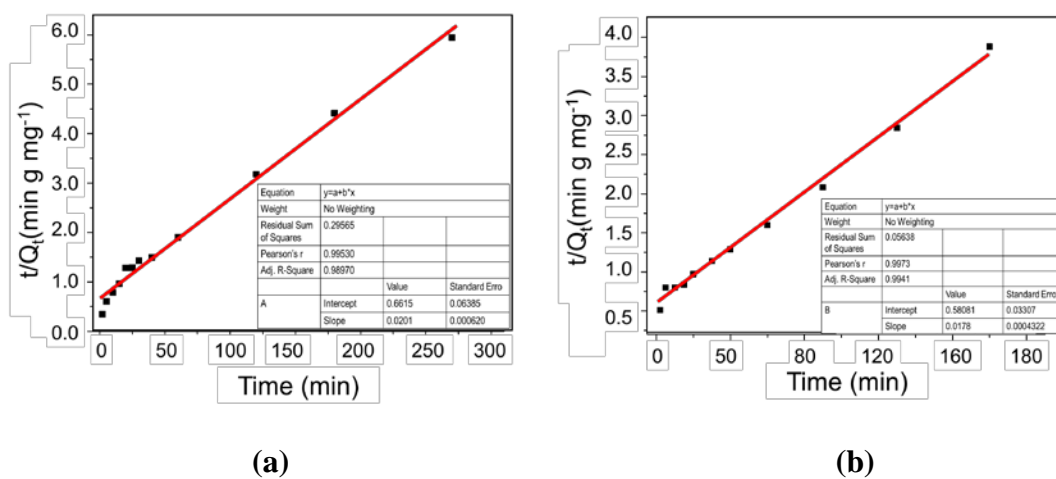
**Figure S20.** The Contact angle images for T-CMP (left) and T-CMP-Me (right) with water.



**Figure S21.** The maximum adsorption of dyes (CV<sup>+</sup>, MB<sup>+</sup>, RB<sup>+</sup>, BR<sup>+</sup>, DY) of T-CMP.



**Figure S22.** Time-dependent UV adsorption rates of MB<sup>+</sup> dyes T-CMP and T-CMP-Me, respectively.



**Figure S23.** Pseudo-second-order kinetics for adsorption of MO (a) and AO (b) in the presence of T-CMP-Me.

**Table S1.** Data summary energy spectrum analysis for T-CMP.

| Elt. | Line | Intensity (c/s) | Atomic % | Conc    | Units |       |
|------|------|-----------------|----------|---------|-------|-------|
| C    | Ka   | 1.86            | 14.229   | 6.780   | wt. % |       |
| N    | Ka   | .51             | 4.210    | 2.340   | wt. % |       |
| Si   | Ka   | 29.67           | 81.561   | 90.880  | wt. % |       |
|      |      |                 | 100.000  | 100.000 | wt. % | Total |

**Table S2.** Data summary of the different kinds of dyes (label, structure, charge).

|           | Neutral | Anionic         |                 | Cationic        |                 |                 |                 |
|-----------|---------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Name      | DY      | AO <sup>-</sup> | MO <sup>-</sup> | MB <sup>+</sup> | CV <sup>+</sup> | BR <sup>+</sup> | RB <sup>+</sup> |
| Structure |         |                 |                 |                 |                 |                 |                 |
| Charge    | 0       | -1              | -1              | +1              | +1              | +1              | +1              |

DY: dimethyl yellow; AO: Acid orange; MO: methyl orange; MB: methylene blue;

CV: crystal violet; BR: basic red; RB: rhodamine B.

**Table S3.** Comparison of constants calculated based on respective pseudo-second-order kinetics.

|    | T-CMP          |                | T-CMP-Me       |                |
|----|----------------|----------------|----------------|----------------|
|    | Q <sub>e</sub> | K <sub>2</sub> | Q <sub>e</sub> | K <sub>2</sub> |
| MB | 67.80          | 0.000701       | 59.14          | 0.00152        |
| CV | 51.79          | 0.00232        | 50.51          | 0.00279        |
| RB | 51.02          | 0.000651       | 46.51          | 0.00139        |
| MO | _*             | _*             | 49.75          | 0.000611       |
| AO | _*             | _*             | 56.18          | 0.000546       |

The symbol \* stands for meaningless and cannot be fitted correctly.