

## Supplementary Information

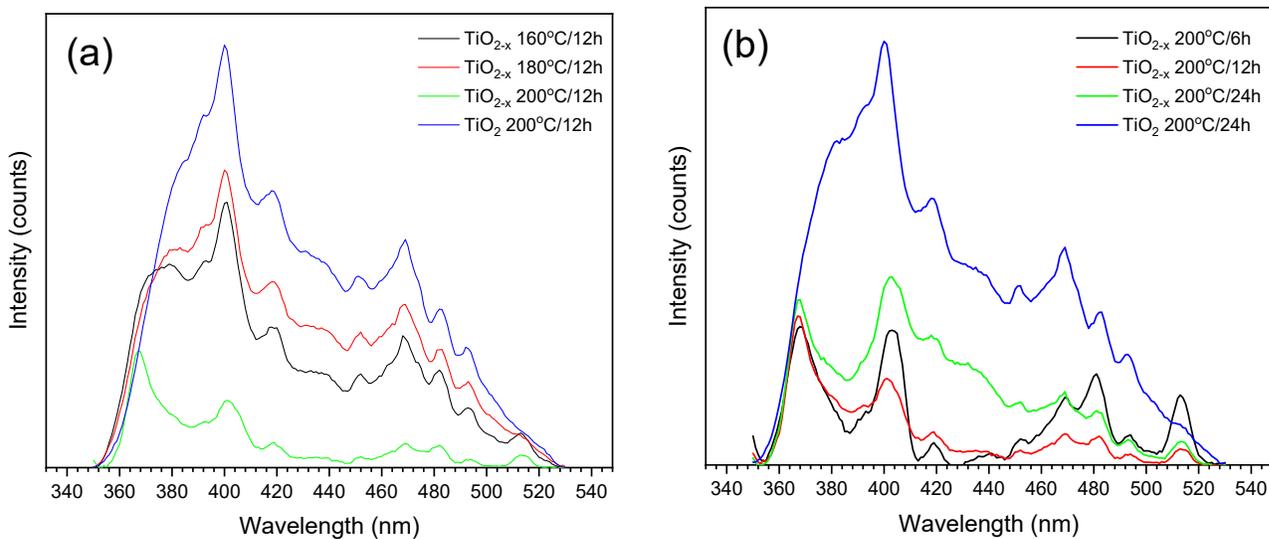


Fig. S1 PL spectra of the prepared samples at different hydrothermal (a) temperatures and (b) times.

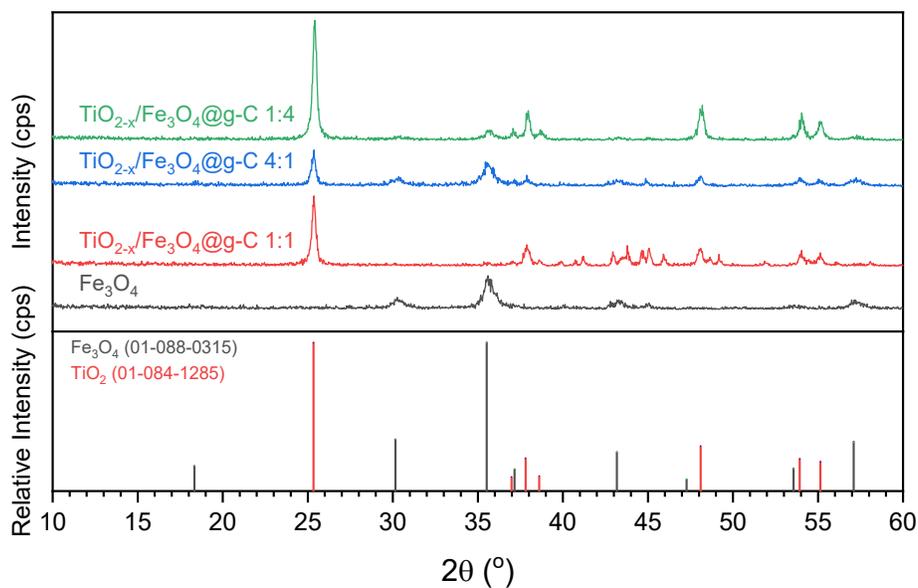
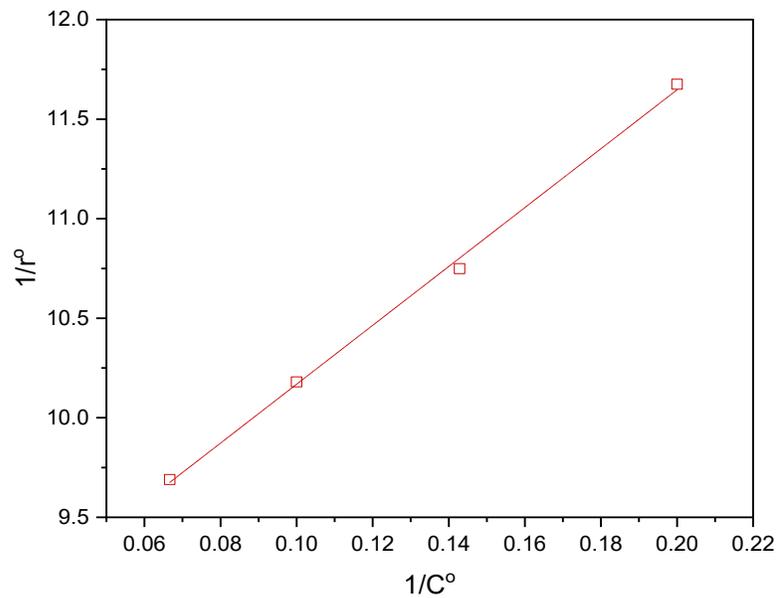


Fig. S2 XRD patterns of pure  $\text{Fe}_3\text{O}_4$  and the prepared composites.

The Langmuir-Hinshelwood (L-H) mechanism defines a heterogeneous catalysis process wherein reactants are adsorbed onto the catalyst surface, react, and subsequently desorb as products. This mechanism emphasizes the importance of surface interactions and is crucial for understanding reaction kinetics and the efficiency of catalysts. So, in order to deeply investigate the adsorption step in the photocatalytic degradation of phenol, the linear form of L-H model (Quyen et al. 2019) indicated in Eq. 1, was applied on the optimum sample  $\text{TiO}_{2-x} : \text{Fe}_3\text{O}_4/\text{g-C 2:1}$ .

$$\frac{1}{r^0} = \frac{1}{k} + \frac{1}{kKC^0} \quad (1)$$

Where  $r^0$  is the initial rate of reaction,  $C^0$  is the initial concentration of phenol,  $k$  is the L-H reaction rate and  $K$  is the equilibrium adsorption constant. The plot  $1/r^0$  versus  $1/C^0$  is shown in Fig. S3. The correlation coefficient for the L-H equation was nearly unity ( $R^2 = 0.9982$ ), indicating that the phenol catalytic oxidation data involves an adsorption step. The L-H reaction rate ( $1/k$ ) and equilibrium constant ( $1/K$ ) were obtained from the slope and the intercept of regression line, which were  $14.789 \text{ (mg L}^{-1} \cdot \text{min}^{-1})$  and  $8.68 \text{ (L mg}^{-1})$ , respectively.



*Fig. S3 Langmuir–Hinshelwood kinetic model of the catalytic oxidation of phenol*

Quyen, N.D.V., Tuyen, T.N., Khieu, D.Q., Hai, H.V.M., Tin, D.X. and Itatani, K. (2019) Oxidation of dibenzothiophene using the heterogeneous catalyst of tungsten-based carbon nanotubes. *Green Processing and Synthesis* 8(1), 68-77.