Electronic Supplementary Material (ESI) for RSC Advances

Supporting information

Synthesis and catalytic performance of La or Ce doped hydroxy-FeAl intercalated montmorillonite used as heterogeneous photo Fenton catalysts under sunlight irradiation

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Table S1: Main characteristics of C.I. Reactive Blue 19 (RB19)

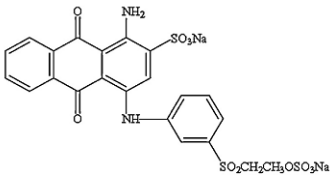
Characteristics	C.I. Reactive Blue 19
Strucuture	
Molecular formula	$C_{22}H_{16}O_{11}N_2S_3Na_2$
Molecular weight	626.6 g/mol
λ_{max}	590 nm

Table S2: Infrared frequencies and assignment of montmorillonite samples.

Position/cm^{-1}	Assignments
3624	OH stretching of structural hydroxyl groups
3434	OH stretching of H_2O
1641	OH deformation of H_2O
1087	Si-O stretching of cristobalite
1034	Si-O stretching
915	Al-Al-OH deformation of structure
795	Si-O stretching of cristobalite
625	Coupling of Al-O and Si-O, out of plane
518	Al-O-Si deformation
467	Si-O-Fe deformation

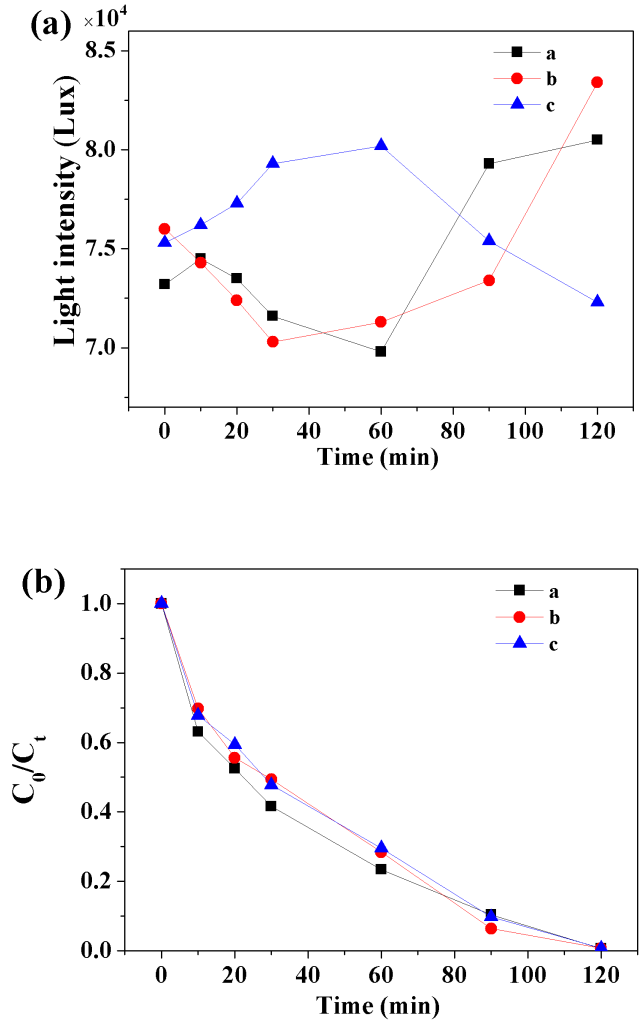


Fig. S1. Effect of sunlight intensity on the catalytic degradation performance. (exemplified by FeAl/Ce1.0-Mt). The experimental conditions: initial concentration of 0.12 mM RB19, 14.7 mM H_2O_2, catalyst dosage 0.5 g/L, pH 3.0.

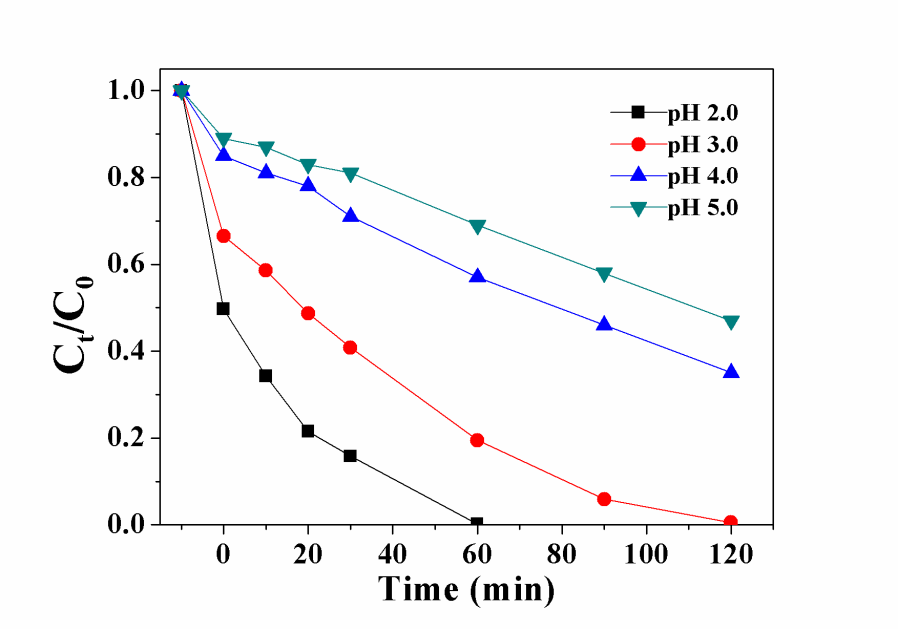


Fig. S2. The effect of initial pH on the catalytic performance of heterogeneous photo Fenton reaction (exemplified by FeAl/Ce1.0-Mt). The experimental conditions: initial concentration of 0.12 mM RB19, 14.7 mM H_2O_2, catalyst dosage 0.5 g/L.

The pH at which reaction takes place plays an important role in the catalytic performance of heterogeneous photo Fenton reaction. A set of experiments was conducted to investigate the effect of initial pHs ranging from 2.0 to 5.0 on the decolorization of RB19. As is presented in Fig. S2, the catalytic performance is significantly affected by the initial pHs. Obviously, the final decolorization efficiency of RB19 increased from 53.6% to 99.6% when the initial pH was decreased from 5.0 to 2.0. Based on the observation, pH 3.0 was chosen as the optimum pH in this reaction system for further experiments.

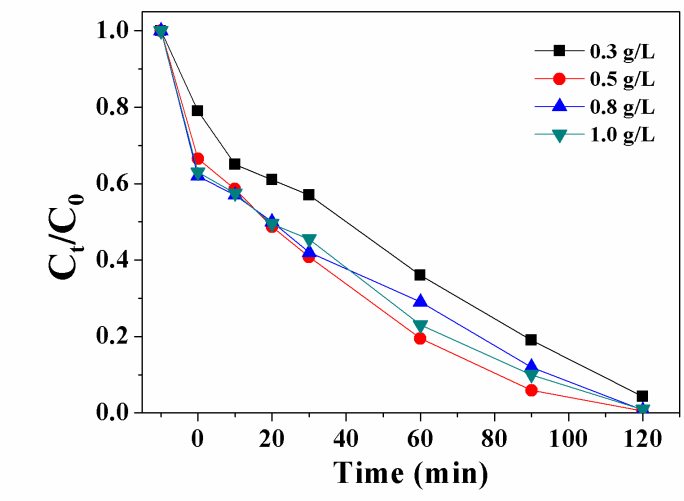


Fig. S3. The effect of catalyst dosage on the catalytic performance of heterogeneous photo Fenton reaction (exemplified by FeAl/Ce1.0-Mt). The experimental conditions: initial concentration of 0.12 mM RB19, 14.7 mM H_2O_2, pH 3.0.

The effect of catalyst dosage on the catalytic performance of RB19 decolorization was investigated by varying the catalyst dosage from 0.3 to 1.0 g/L. As can be seen in Fig. S3, the curves of decolorization efficiency of RB19 as a function of time were similar with the catalyst dose ranging from 0.5 g/L to 1.0 g/L. It is believed that the obtained catalyst employed as a Fenton catalyst could accelerate the decomposition of H_2O_2 and more ·OH radicals are generated with increment of catalyst dosage. In fact, catalyst particles would make the reaction solution turbid if the dosage of catalyst was high, as a result, the penetration of sunlight was diminished, which hampered the production of ·OH radicals. Taken consideration of the cost, a suitable catalyst dosage for the removal of RB19 by heterogeneous photo Fenton reaction under sunlight irradiation is 0.5 g/L at an initial concentration of the RB19 and H_2O_2 mentioned above.

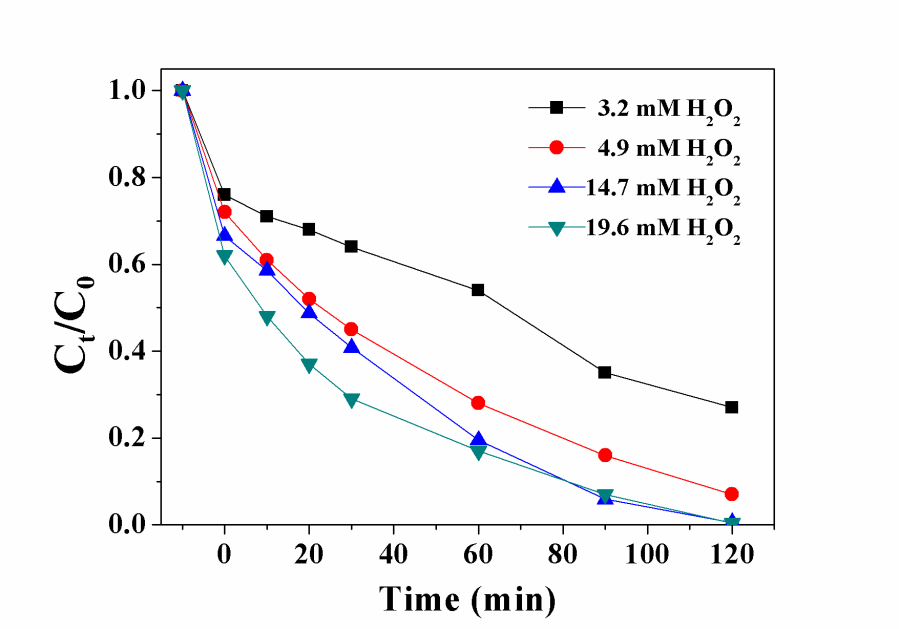


Fig. S4. The effect of initial concentration of H_2O_2 on the catalytic performance of heterogeneous photo Fenton reaction (exemplified by FeAl/Ce1.0-Mt). The experimental conditions: initial concentration of 0.12 mM RB19, catalyst dosage 0.5 g/L, pH 3.0.

The effect of initial concentration of H_2O_2 on the catalytic performance of heterogeneous photo Fenton reaction was studied. As can be observed, with increasing initial concentration of H_2O_2 from 3.2 to 19.6 mM, the decolorization efficiency of RB19 went up from 36.1% to 71.4% at 30 min. The increase of decolorization rate by adding more H_2O_2 resulted from the increase of ·OH radicals. However, when the initial concentration of H_2O_2 reached 14.7 mM, the decolorization efficiency of RB19 decreased slightly. The number of ·OH radicals in solution decreases because the scavenging of ·OH radicals occurs at a higher concentration of H_2O_2. This process can be proposed to follow the reaction formulas

as listed below (Eqs. (R1)–(R2)).

$$H_2O_2 + \cdot OH \rightarrow H_2O + \cdot HO_2 \quad \text{(R1)}$$

$$\cdot HO_2 + OH \rightarrow H_2O + O_2 \quad \text{(R2)}$$

Therefore, a suitable initial H_2O_2 concentration of 14.7 mM can be regarded as the optimum initial concentration for the remvoal of RB19 by heterogeneous photo Fenton reaction.