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Enhanced photocatalytic degradation of oxytetracycline using $LaFeO_3$ supported on Mullite ceramic foam

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INTRODUCTION & AIM

The immobilization of a photocatalyst on a solid support is essential for practical environmental applications, as the photocatalyst is then not dispersed in the solution with contaminants and can be recycled several times. $LaFeO_3$ powder and $LaFeO_3$ supported on a mullite-based ceramic foam are promising materials for the photocatalytic degradation of oxytetracycline (OTC) under visible light irradiation and in the presence of H_2O_2.

METHOD

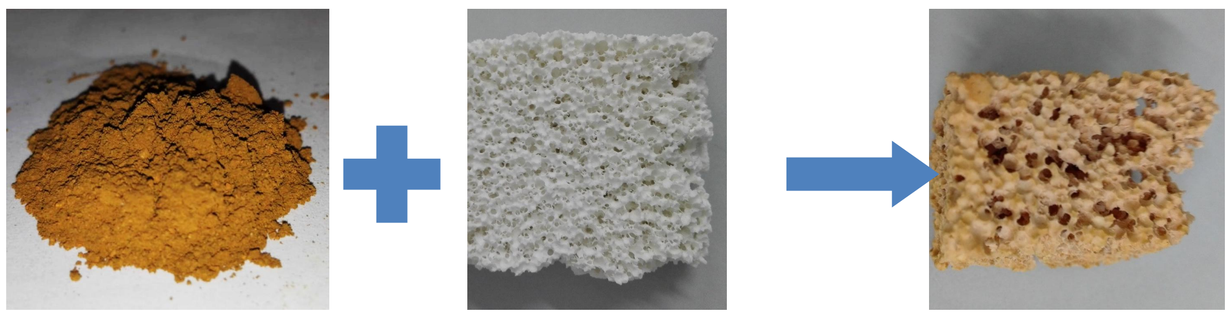

Figure 1. (A) $LaFeO_3$ powder, (B) pristine mullite foam; (C) $LaFeO_3$ supported on the mullite foam.

Table 1. experimental conditions

Photocatalyst	Light Source	[OTC] (mol L^{-1})	[H_2O_2] (mol L^{-1})
$LaFeO_3$ supported on a mullite-based ceramic foam	2 Daylight, 8W each	5.0×10^{-6}	3.0×10^{-3}

Parallel tests were carried out, one with the $LaFeO_3$ supported on the mullite foam (Fig. 1C), the other with the mullite foam without catalyst (Fig 1B). The mixtures were stirred in the dark for 20 minutes to allow adsorption/desorption equilibrium on the mullite foam and catalyst surface. Then the two fluorescent lamps (daylight, 8 W each, irradiance on the sample 89 Wm^{-2}) emitting in the 380-780 nm region were turned on for 240 min.

RESULTS & DISCUSSION

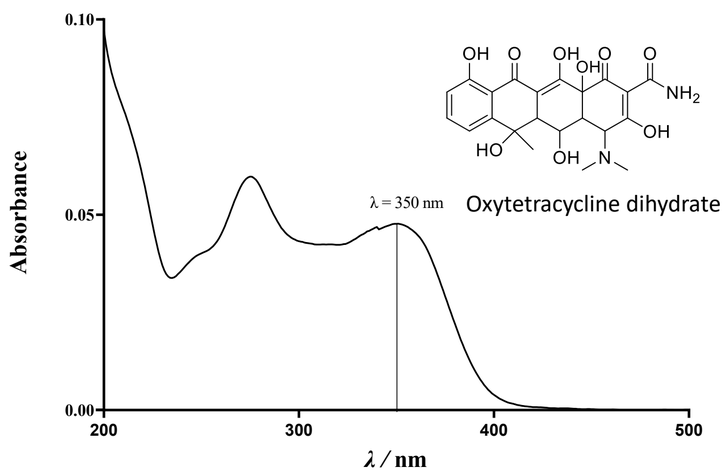

Figure 2. UV–Vis absorption spectra of Oxytetracycline and its chemical structure.

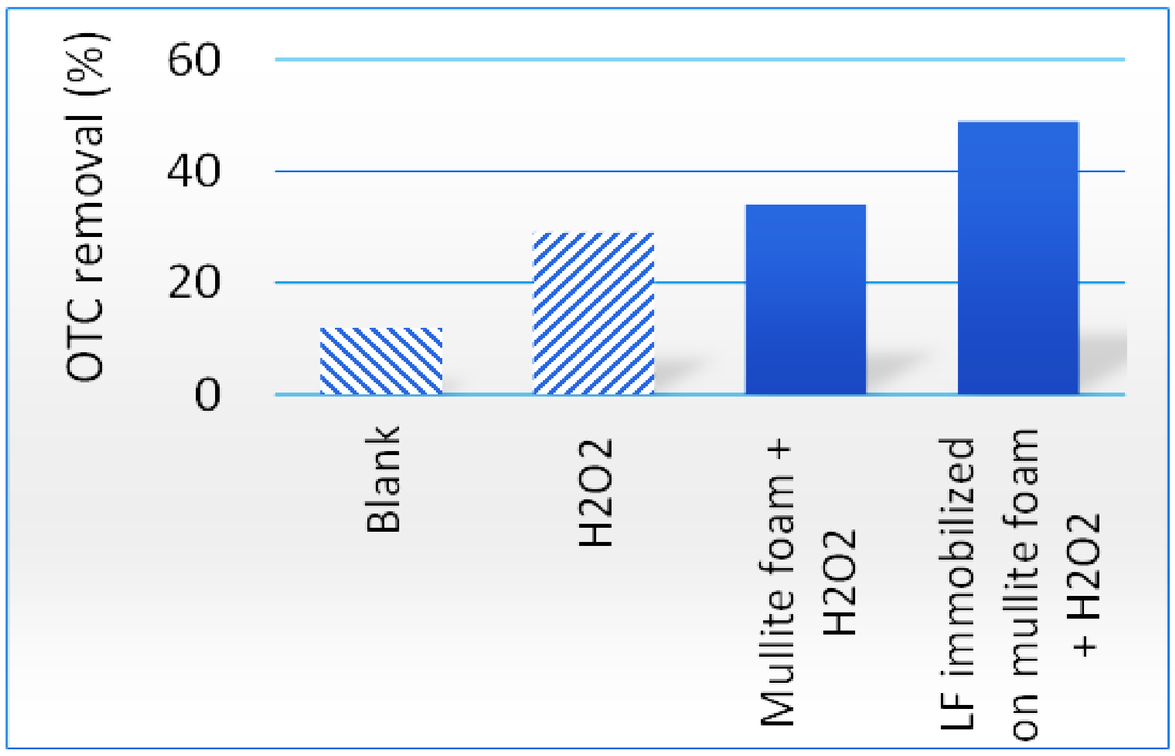

Figure 4. photocatalytic degradation of OTC after 240 min of visible light irradiation. LF = $LaFeO_3$. $C_0=5{\cdot}10^{-6}$ M, the OTC solution is phosphate buffered at pH = 5.0 since at pH=5.0 OTC is poorly photolyzed.

The point of zero charge (PZC) for $LaFeO_3$ is at pH= 8.9 suggesting that the surface charge of catalyst is positive in our tests. OTC exists predominantly as a zwitterion between pH 3.6 and 7.5 resulting from the loss of proton from the phenolic diketone moiety.

CONCLUSION

- Plain mullite foam and $LaFeO_3$ supported on the mullite foam degraded 34% and 50% of OTC respectively, after 240 min of irradiation, in presence of H_2O_2.
- A small addition of H_2O_2 increases the photodegradation rate of organic pollutants by removing the surface-trapped electrons, thereby lowering the electron-hole recombination rate and increasing the efficiency of hole utilization for reactions, such as $OH^- + h^+ \rightarrow \bullet OH$.
- In this study the OTC solution is buffered at pH = 5.0, so OTC has zwitterionic form. Physisorption of OTC molecules on the catalyst promotes photodegradation of the contaminant by their surface diffusion to the photocatalytic sites.