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Sonophotochemical activation: Which opportunities for the selective oxidation of alcohols?

AUTHORS

CHEVALLIER Marion / UNIVERSITÉ SAVOIE MONT BLANC, ,
CHEVALLIER Marion / UNIVERSITÉ SAVOIE MONT BLANC, LABORATOIRE DE CHIMIE MOLÉCULAIRE ET ENVIRONNEMENT (LCME), CHAMBÉRY
Lucile BRUYAT / UNIVERSITÉ SAVOIE MONT BLANC, LABORATOIRE DE CHIMIE MOLÉCULAIRE ET ENVIRONNEMENT (LCME), CHAMBÉRY
Fanny SERRES / UNIVERSITÉ SAVOIE MONT BLANC, LABORATOIRE DE CHIMIE MOLÉCULAIRE ET ENVIRONNEMENT (LCME), CHAMBÉRY
Bernard DAVID / UNIVERSITÉ SAVOIE MONT BLANC, LABORATOIRE DE CHIMIE MOLÉCULAIRE ET ENVIRONNEMENT (LCME), CHAMBÉRY
Gregory CHATEL / UNIVERSITÉ SAVOIE MONT BLANC, LABORATOIRE DE CHIMIE MOLÉCULAIRE ET ENVIRONNEMENT (LCME), CHAMBÉRY
Corresponding author : Marion CHEVALLIER / chevallier.marion@hotmail.fr

PURPOSE OF THE ABSTRACT

The synergistic combination of sonocatalysis (US) and photocatalysis, called sonophotocatalysis (Figure 1) has been reported in the literature, especially for the degradation of organic compound in aqueous phase, as an advanced oxidation process (AOP) for water decontamination.[1] Indeed, the combined effects present some advantages such as the increased amount of radical species generated in aqueous solution and the turbulence induced by cavitation phenomenon, leading to the renewal of the photocatalyst surface. Both effects induce the increase of degradation reaction rates.

We recently showed that even if the major part of literature on sonophotocatalysis is focused on the advanced oxidation processes, some other original applications start to be demonstrated in chemistry.[2] For example, the US/UV-TiO2 combination led to the conversion of malonic acid to CO2 (23%), CO (47%), CH3COOH (21%) and HCOOH (9%) after 6 h of treatment.[3] Interestingly, some traces of succinic acid were detected after 48 h of irradiation. In this context, the proposed research is focused on the application of sonophotocatalysis for the selective oxidation of specific alcohols to produce aromatic carboxylic acids of interest, through the in-situ production of active oxygen-based species.

In the framework of the SONOPHOTOCHEM project (funded by French Agency of Research, ANR), we investigated the major impacting parameters on the selective oxidation of model aromatic alcohols into corresponding carboxylic acids, under ultrasound, UV-TiO2 and both irradiations to (i) better understand the associated mechanisms and (ii) efficiently control the selective oxidation reaction. The blank reactions also allowed highlighting the sonophotochemical effects in these reactions.

Through the design and the use of an evolutionary sonophotochemical prototype reactor, preliminary results were obtained to (i) explain the action of TiO2 with ultrasound, with UV light, and in the presence of both; (ii) determine the influence of ultrasonic frequencies on the selective oxidation of aromatic alcohols; (iii) understand the effects of different experimental conditions (concentration of the substrate, solvent, temperature, etc) on the efficiency and the selectivity of the reaction.

FIGURES

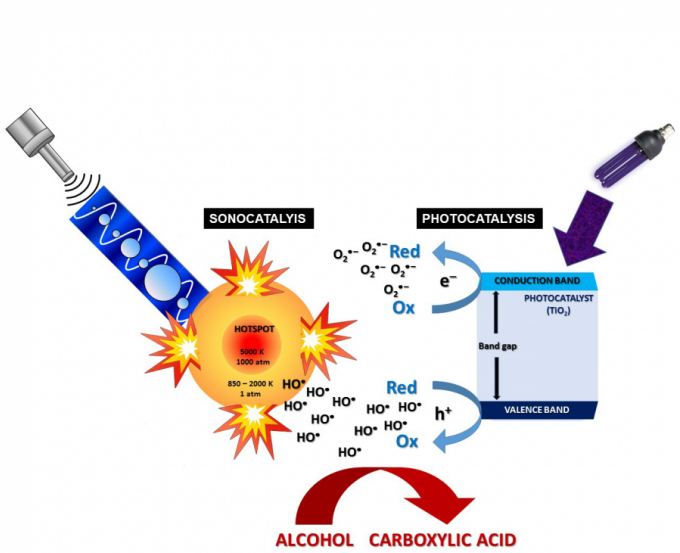

FIGURE 1

Principle of sonophotocatalysis of the selective oxidation of alcohols

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FIGURE 2

KEYWORDS

green chemistry | sonochemistry | photochemistry | selective oxidation

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