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WATER: FROM POLLUTION TO PURIFICATION

Micro-sized TiO_2 as photoactive catalyst coated on industrial porcelain grès tiles to photodegrade drugs in water

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Abstract Pharmaceutical compounds and their metabolites raise worrying questions because of their continuous release and lack of efficient removal by conventional wastewater treatments; therefore, they are being detected in groundwater, surface water and drinking water in increasing concentrations. Paracetamol and aspirin are two of the most commonly used drugs employed as fever reducer, analgesic and anti-inflammatory. They and their metabolites are very often found in river water, so their degradation is necessary in order to render water suitable for human consumption. The present work is focused on the comparison of the photocatalytic performance of industrial active grés porcelain tiles covered with a commercial micro-sized TiO_2 by industrial process using either conventional spray deposition or innovative digital printing methods. The photodegradation of two commonly used drugs, namely aspirin and paracetamol, was investigated both individually and as a mixture, in both deionized and tap water. The results reveal the full conversion of the drugs and the significant role of the photocatalytic tiles in the mineralization processes leading to harmless inorganic species. In particular, the digitally printed tiles exhibited better photodegradation performance for both drugs compared to the spray deposited tiles. No deactivation was observed on both photocatalytic tiles.

Keywords Digital printing deposition · Pharmaceutical compounds · Photoactive tile · Titanium dioxide · Water remediation

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Introduction

Nowadays, thanks to new analytical methods and procedures, we are aware that the water bodies need urgent attention to correct the adverse impact of humans and thus restoring the pristine environmental conditions. Directive (EU) 2013/39/EU and subsequent Directive (EU) 2015/1787 state new regulations to monitor the quality of the aquatic environment, with special attention on water for to human consumption (http://eur-lex-europa.eu 2016). Pharmaceutical compounds and their metabolites raise worrying questions because they are continuously released and are not efficiently removed by conventional wastewater treatments; therefore, they are detected in groundwater, surface water and drinking water in increasing concentrations (Rivera-Utrilla et al. 2013; Verlicchi et al. 2015). Advanced oxidation processes (AOP) allow for removal of these recalcitrant organic compounds, due to the generation of free radicals ($HO^{\cdot}$, $O_2^{\cdot-}$), with high reactivity and low selectivity (Dey 2009). TiO_2 catalyst powder has attracted considerable attention, due to its biological and chemical stability, low cost and mainly its capability to exploit natural and renewable solar UV light to degrade complete mineralization the organic pollutants (Linsebigler et al. 1995; Diebold et al. 2010). Its industrial applications are not practicable because of the difficult recycling of the ultrafine TiO_2 particles from the treated water (Kinsinger et al. 2015;