Photo- and piezo-catalysis as the winning pair for the fast and efficient mineralization of ibuprofen by bismuth oxybromide under solar light irradiation

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In recent years, the water crisis and continuous contamination of water basins have posed a serious threat to water resources and society well-being. Pharmaceutical and personal care products, steroids, and hormones are just some pollutants found in water [1]. Among these, the most well-known pharmaceutical category is that of non-steroidal anti-inflammatory drugs (NSAIDs), whose ibuprofen (IBU) belongs. Recently, it has been demonstrated that IBU can be found in untreated municipal wastewater and in hospital or industrial production waste [2]. Accordingly, researchers have addressed efforts in developing new methods for its abatement. Among the different approaches, heterogeneous photocatalysis has emerged because it uses semiconductors and a source light to produce oxidants (*i.e.*, $OH\cdot$, $O_2^{-\cdot}$, $HO_2\cdot$ radicals) to mineralize organic contaminants to carbon dioxide and water [3]. However, the fast photo-induced electron-holes recombination limits its practical use, since it leads to the diffusion of the produced charges at the photocatalyst surface, strongly reducing the photocatalytic activity. The urgency to identify more performant photocatalysts able to reach complete and fast mineralization of ibuprofen by sustainable approaches is thus evident. In this context, piezophoto-catalysis can be a valuable solution: the use of ultrasound vibrations promotes electric charges at the photocatalyst surface, enhancing the photoinduced charge separation by the piezoelectric effect. In this way, redox reactions involved in organic pollutants degradation are promoted by the free charges accumulated on the material surface [4].
Herein, we have investigated for the first time the photo- and piezo-photocatalytic properties of bismuth oxybromide nanosheets (BiOBr, Figure 1a) in the IBU degradation in different water matrices (ultrapure and simulated drinking water) to evaluate the potential application of the piezo-photocatalyst in real environments [4]. Figure 1b resumes some results in terms of mineralization capacity values obtained in the presence of different BiOBr dosages. In general, the higher is the BiOBr dosage, the higher is the mineralization capacity. Complete mineralization is obtained when 0.5 $g\cdot L^{-1}$ BiOBr dosage is used. The main results obtained in terms of the identification of the main active species involved in the degradation process by trapping holes/radicals using proper scavengers and transformation products will be also discussed.

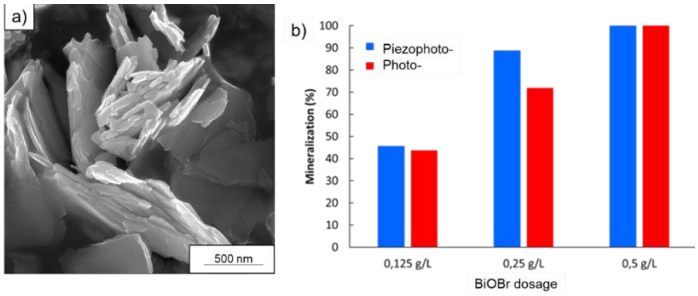

Figure 1: a) FESEM micrographs of BiOBr nanosheets; b) Mineralization results of photo-, and piezophoto-degradation of IBU (50 $mg\cdot L^{-1}$) in the presence of different BiOBr dosages in ultrapure water obtained at the process end (30 min dark *plus* 180 min under solar irradiation, 35 $W\cdot m^{-2}$).

[1] Ellis, J.B. Environ. Poll. 2006, 144(1), 184; [2] Marković, M. *et al.*, Sci. Total Environ. 2015, 505, 1148 ; [3] Ma, D. *et al.*, Chemosphere 2021, 275, 130104 ; [4] Falletta, E. *et al.*, ACS Photonics, under review.