WATERGREENTREAT

A green approach in the frame of circular economy: robocasted photocatalysts for wastewater treatment and use of reclaimed water in agriculture

Water4All
Water security for the planet

Abstract

The aim of this proposal consists in the obtaining macroporous photocatalysts based on ecogenic metal oxides (ecoMO) (ZnO/CuO) composites through the robocasting technique, but also the evaluation the synergistic effect induced by the presence of microalgae in the removal of specific pollutants for wastewater treatment and the use of regenerated water in agriculture.

The main objectives of the project are the following:

I. green synthesis of photo-catalysts based on metal oxides (ZnO, CuO) nanoparticles (NPs),
II. 3D-printing structures based on ecogenic metal oxides by robocasting,
III. the use of the obtained 3D photocatalytic structures based on metal oxides NPs to remove contaminants such as antibiotics or dyes from the wastewater generated by pharmaceutical/textile industry,
IV. the use of the microalgae to reduce the pollutant species generated during the photocatalysis process, and (v) the assessment of the synergistic effect induced by the 3D photocatalytic structures and microalgae at laboratory/ semi-industrial/greenhouse level on synthetic wastewater (by adding drugs/dyes) and in real wastewater (treatment plants).

This project has the following specific objectives:

- 1) Phytosynthesis and characterization of metal oxide, metallic NPs and their composites.
- 2) The use of ecoMO to treat, in laboratory, various synthetic wastewaters (containing organic dyes, drugs, etc.).
- 3) In vitro biological investigations [cytotoxicity evaluation by acute and chronic Aliivibrio fischeri assays (ISO 11348), acute algae (OECD 201) and Daphnia (OECD 202), and zebrafish embryo toxicity assay (OECD 236)]; and the ecoMO bio-impact on terrestrial and aquatic media will be tested.
- 4) The synthetic/real wastewaters (before and after the treatment with robocasted photocatalysts based on ecoMO composites) will be tested as follows: (i) in vivo on plants grown in the greenhouse (didactic and scientific research resort); (ii) in vitro on Aliivibrio fischeri for acute cytotoxicity (ISO 11348 standard) and for chronic toxicity in a high throughput assay adapted to microplates; Daphnia acute tests; and acute toxicity measurement on zebrafish eggs for wastewater qualification (ISO 15088).
- 5) Evaluation of the detoxification efficiency of different composite samples based on ecological metal oxide (ecoMO) nanoparticles and their robocasted photocatalysts by microalgae culture in a treated wastewater environment, but also of the synergistic effect induced by the presence of microalgae on the ecological composite of metal oxide nanoparticles or their robocasted photocatalysts based on ecoMO composites for the removal of certain pollutants.

Upon our knowledge, there are no reports regarding robocasted photocatalysts based on ecoMO composites (ZnO/CuO). In the frame of circular economy, it is necessary to identify and develop efficient technologies for treatment of the residual waters generated by pharmaceutical, textile, etc. industries in order to use the reclaimed water for agriculture. The elimination of the pharmaceutically active compounds (PhACs) and dyes from water generated from pharmaceutical and textile industry is vital for using the reclaimed water in other fields such as agriculture. Thus, reclaimed water obtained through a synergistic effect induced by 3D-printed photocatalytic structures and microalgae can be used in agriculture activities. Moreover, taking into account that the increase of periods with high temperature has the direct effect of decreasing the flow of surface water, which also influences the flow of shallow underground water, the population can be constrains to reduce the crop irrigation. This impediment can be mitigated by reusing treated wastewater in agriculture. Consequently, the outcome of our proposal can improve the resilience and adaptation capacity of wastewater treatment facilities within the frame of hydroclimatic extreme events.

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