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Abstract

Bioremediation Using Microalgae and Circular Economy Approach: A Case Study †

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Water pollution is a global problem that affects our society and all Earth's ecosystems.

Nano and microplastics, pharmaceuticals, heavy metals, plasticizers, and thousands of other organic and inorganic molecules are found in waters and represent a serious health risk and a challenge in the field of wastewater technology [1,2].

Through a sustainable model of circular bioeconomy, potential solutions are proposed and analysed in this study, more specifically, the use of microalgae as a tool in wastewater treatment. At first, the wastewater profile was performed using electronic, optical, and fluorescence microscopies, Fourier-transform infrared (FTIR), Raman, and atomic absorption spectroscopies. The analyses revealed the presence of different polymeric matrices such as polycarbonate, polyurethanes, and allyl diglycol carbonate. It also showed the presence of heavy metals and persistent organic molecules.

After separating the suspended solids, microalgae were used to remove pollutants from wastewater. The separated solids can be used as fillers to produce mortar and polymer-based composites. The microalgae biomass generated in the bioremediation process can be converted into feedstock for biobased products for advanced applications. One such application includes ophthalmic lenses made from polylactic acid (PLA). After the bioremediation using microalgae, the maximisation of lipids, and their extraction, it is possible to obtain feedstock for producing PLA; the lipids can be used as a feedstock for the production of various chemicals. We evaluated the feasibility of PLA for applications in advanced optical products through the thermal and optical analyses using Differential Scanning Calorimetry (DSC), Polarized light thermo-microscopy (PLTM), and Refractive index and Abbe number measurements. The refractive index and Abbe number of PLA lenses were 1.46 and 55.24, respectively. PLA lens presented good performance compared to the commercial ones and is suitable for its application in ophthalmic lenses.

With the approach presented in this work, pollution can be converted into a sustainable economic model.

This study presents a case study where industrial wastewater is characterised, reused, bioremediated, and converted. Opportunities and challenges were identified and overcome in the transition toward a more circular economy.

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