Ecole Doctorale des Sciences Fondamentales

Title of the thesis: Tunning the durability of "recycled" polymer materials through 3D printing

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Summary :
The theme of Polymers Life Cycle (PLC) in the team of Photochemistry focuses on new bio-based polymer materials, in particular, their lifetime durability and recycling through innovative processes such as 3D printing.

Preliminary works concerning the 3D printing of polymers and composites have been done at PLC theme and showed that the kinetics of photoaging of printed samples may vary according to the filling rate and the pattern of the print (linear, gyroid, cubic…). These preliminary studies are stopped at this level without a thorough understanding of this variation which can be a very interesting way to control the durability of 3D printed materials in the future. To date, to the best of our knowledge, there is no study highlights this phenomenon.

At the same time, previous works have shown that the impact of the additive manufacturing process (by thermomechanical degradation) on polymer materials is almost negligible compared to conventional processing methods[1]. These results can directly influence the durability of polymer materials because aging is sensitive to the thermomechanical degradation which takes place during processing. Once again, additive manufacturing demonstrates that it can be an interesting process to improve the durability of polymer materials, more particularly in the case of recycled polymer materials that have already undergone prior aging.

Considering the lack of data in the literature on this subject, the preliminary study allowed us to identify an experimental method to understand the main effects of the printing pattern and the impact of printing on the photo-degradation of polymer materials. To this end, the proposed thesis work will initially aim to develop "recycled" polymer materials with controlled lifetime durability. A second part of the thesis will be addressed to the environmental impact of the proposed eco-products, by analyzing more specifically the ultimate end of life and the molecular products resulting from thermal or photochemical degradation.

[1] Askanian, H., Muranaka de Lima, D., Commereuc, S., & Verney, V. (2018). Toward a better understanding of the fused deposition modeling process: comparison with injection molding. 3D Printing and Additive Manufacturing, 5(4), 319-327.