Premières rencontres nationales du GDR Polymères et Océans
Université Paris-Est Créteil, 24 – 26 juin 2019

Biodegradation assessment of PHBV and PBSA in controlled conditions: A critical analysis of different methodological approaches

Mélanie Salomez[1], Matthieu George[2], Pascale Fabre[2], François Touchaleaume[1], Guy césar[3], Emmanuelle Gastaldi[1]

With the increase of the global population, the demand for plastic materials in every aspect of life and industry has become tremendous, the packaging sector being the first to both use plastics and produce plastic wastes, whose a great part will irremediably end up in ocean [1]. To face the environmental issues stemming from the accumulation of conventional plastics, biodegradable plastics, whether they derive from renewable feedstocks or petroleum, are seen as promising alternatives. Among the biodegradable plastics suitable for replacing conventional plastics, the family of aliphatic polyesters PHAs and PBS are both interesting candidates for satisfying the functional requirements of a daily use plastic with a low environmental impact.

In this context, the present study aims at providing a critical assessment of the main methodological approaches commonly used to monitor and evaluate biodegradation of polymer under controlled conditions. For this purpose two biodegradable polyesters have been compared for their degradation behaviour in a compost environment at laboratory scale, which was chosen here as accelerated biodegradation conditions. The first selected plastic was Poly-[(butylene succinate)-co-(butylene adipate)] (PBSA 21%mol BA, Natureplast PBE001), a partially bio-sourced polymer known for its notable biodegradability, thermoplastic processability and balanced mechanical and thermal properties competitive to those of polyolefins [2]. The second selected plastic was Poly(3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV 1-2%mol HV, Natureplast PHI002), a bio-sourced polymer exhibiting a high rate of biodegradation as attested by the abundant literature dealing with this subject [3]. Both polymers were studied as films (about 200µm thick) obtained by extrusion from pellets of commercial grade.

The advance of the biodegradation process was assessed by monitoring the extent of material disappearance through both mass loss and CO_2 release measurements, in combination with other methods evidencing the morphological, structural and chemical modifications induced at the surface and/or in the bulk of the material such as surface erosion by MEB and AFM, molecular weight decrease by GPC, crystallinity changes by DSC and chemical changes by ATR-FTIR.

Correlating such approaches would not only help identifying the key parameters explaining the differences in biodegradability between the two polymers but would also provide a critical analysis of indicators that could be considered as relevant quantitative descriptors for evaluating the level of the overall biodegradation process.

[1]*UMR IATE Ingénierie des Agropolymères et Technologies Emergentes, Campus INRA-SupAgro, 1 place Pierre Viala, 34060 Montpellier, France*
[2]*Laboratoire Charles Coulomb (L2C), Université de Montpellier, CNRS, Place Eugène Bataillon, 34095 Montpellier Cedex 5, France*
[3]*SERPBIO, Université Bretagne Sud, 56321 Lorient, France*

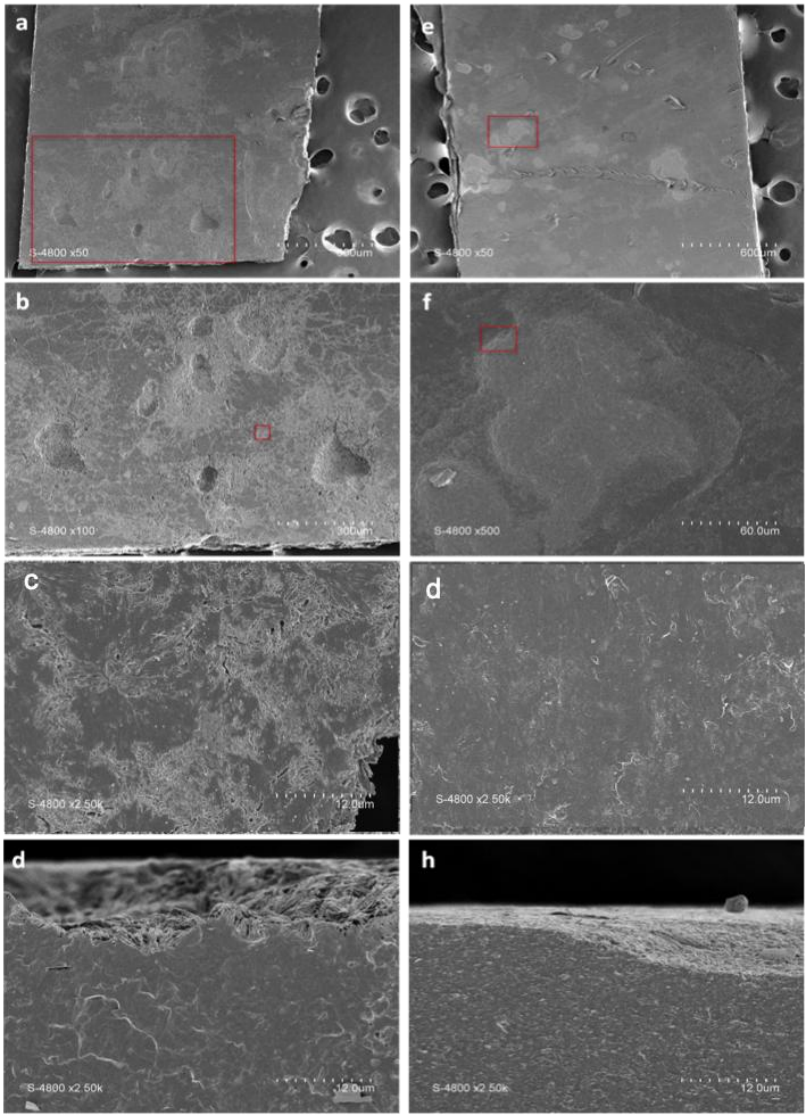

Figure 1 : MEB pictures at different magnifications for PHBV (a,b,c,d) and PBSA (e,f,g,h) films surfaces and cross-sections after 6 days of degradation in compost. Red square corresponds to the area selected for the next magnification

References

[1] Geyer, R., *et al.* Sciences Advances. **2017** 3(7): e1700782
[2] Xu, J., Guo, B.H. Biotechnol Journal. **2010** 5(11): 1149-63.
[3] Numata, K., *et al.* 2009 Materials. **2009** 2:1104-1126.