Final Report

Project acronym: *POLYMAGIC*
Project number*: 4128*
M-ERA.NET Call 20*16*

Period covered: 01/12/2017 to 30/11/2020

Publishable project summary

The objective of POLYMAGIC project was the elaboration of biocompatible and bioabsorbable PLA/Mg composites as implants for osteosynthesis applications (scaffold, screw…) to improve the quality of life of injured and aged people.

Successful processing of composites with Mg microparticles (< 50 µm) have been achieved by several processing techniques, including novel colloidal techniques for their homogenization or surface modification. The resulting colloidal suspension was then used as feedstock to obtain composite films, by tape casting, or granules for further extrusion. At first, homogenous, flexible, free-standing PLA-based films (< 100 µm) thick were successfully obtained with a wide volume fraction range of particles (up to 50%). The presence and content of Mg particles modify the transparency, the colours and the roughness and in general the physical/mechanical properties of the PLA films. Additionally, PLA/Mg granules were extruded as filaments (~ 2 mm in diameter) for 3D printing. In-deep studies related to the thermal behaviour of PLA/Mg granules and films were performed to determine the printing window and the potential thermal degradation of the composites processed through these techniques. Personalized PLA and PLA/Mg composites scaffolds using Fused Deposition Modelling (FDM) were developed. The average molecular weight slightly decreased after 3D printing, which is attributed to polymer degradation during the printing.

Nanocomposites were also developed by using Mg-rod-shape nanoparticles. Films with 40 µm of width and thickness ranged from 40 to 100 mm were processed in a twin screw microextruder using the adequate nozzle. Films of PLA and PLA-OLA were also obtained.

PLA-electrospun fiber mats were obtained after a deeply optimization of the processing parameters in terms of polymer solution, solvent solution as well as processing-window of the electrospinning. OLA has been used as plasticizer. As nanoparticles, commercial MgO and Mg(OH)2 have been introduced in up to 3 wt%, respect the PLA.

In general, a good distribution of Mg particles, micro and nano, have been obtained. A significant result is that a compromise has to be achieved between the use of surfactants/compatibilizer/ plastificant which can improve the PLA/Mg interface and the mechanical performances of the final composites.

The capability of PLA films to bind the protein was evaluated with protein adsorption, evidencing good results and possibility to obtain the expected materials planned in the project. Adult human bone-marrow mesenchymal stem cells and adipose stem cells were used to evaluate the biocompatibility. All films seems to be biocompatible for both types of stem cells.

Scaling-up of the PLA/Mg composite processing has been performed and the materials produced and tested showed performance in line with materials produced at lab scale.

LCA activities have been completed. The analysis of the formulations produced at industrial level has been done and a comparison with the traditional material used as scaffold has been performed showing the good performance of the PLA/Mg formulation produced at industrial scale.