Influence of microstructural parameters on the corrosion properties of a hyper-deformed bioresorbable magnesium alloy

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Abstract: Magnesium alloys are promising candidates for bioresorbable implant applications. In this context, understanding the link between microstructure and corrosion/degradation mechanisms of magnesium alloys is an important issue. The objective of this work was to study the influence of the microstructure on the degradation of a biocompatible Mg-2%Ca alloy. For this purpose, two hyper-deformation processes (Friction Stir Processing and to a lesser extent Equal Channel Angular Pressing) were used to modify the microstructural parameters. These two processes proved to be particularly effective in reducing the grain size (micron-sized grains could be produced), modifying the spatial distribution and size of the second phases present in the alloy and developing specific crystallographic textures. Finally, despite these important microstructural variations, the impact on the degradation rate remains quite limited. The analysis of the electrochemical behaviour helped to decorrelate the influence of these microstructural parameters on the degradation rate; some of them compensating each other. If grain refinement seems to improve the corrosion resistance, due to a coverage of corrosion products probably more coherent with the metal, the role of the second phases appears more complex: the spatial dispersion of the second phase particles has little effect on the electrochemical behaviour whereas the refinement of these particles seems to significantly influence the layer of corrosion products. Finally, as observed on pure Mg and other Mg alloys, crystallographic texture also plays a significant role in corrosion resistance. This work has hence contributed to the improvement of the understanding of the influence of the microstructure on the electrochemical behavior of a magnesium-calcium alloy.