Microstructure, Performance and Characterisation Challenges in rare-earth free biodegradable Mg alloys

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Sustainable development goals along with the criticality of available minerals and recent geopolitical developments demand new material solutions. One of the most abundant in Earth crust, yet second-most critical material for the EU, magnesium (Mg) has excellent potential for addressing most of these demands due to lowest density of all structural metals and friendliness to the environment including biocompatibility.

Relatively modest performance characteristics of pure Mg can be dramatically enhanced and tailored for specific applications through alloying and thermo-mechanical processing. Top-performing modern Mg alloys containing rare-earth (RE) elements supersede strongest aluminium alloys and are on parity with titanium alloys by structural efficiency. Mg-RE alloys might be an excellent solution for light-weight mobility, but highest criticality for the EU and high cost of REs make such alloys less attractive in real-life. Moreover, their application in biomedical sector is questionable due to poorly understood while often toxic effect of REs on human body.

We have been working on the development of magnesium – zinc (Zn) based alloys for biodegradable implant applications. To address the specific challenges of a balance between sufficient strength and controllable degradation upon implantation, minor additions of other elements, all of which are biocompatible and essential for human body, and thermomechanical processing are necessary. The challenges in alloy design are further amplified by those in material performance characterisation due complexity of surface interaction phenomena and correlation between *in vitro* and *in vivo* testing.

In this talk, we overview recent trends in the design of biodegradable magnesium alloys and their achievements in real-life biomedical applications. Special attention is also paid to recent progress in laboratory and large-scale facility based *in situ* characterisation techniques and our contributions to the development of respective experimental methods.