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Editorial

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Special issue "Biodegradable magnesium as implant material"

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It is known since the last century that magnesium (Mg) alloys are favorable in medical applications due to their low elastic moduli, appropriate strength compared to bone, adequate radial force for cardiovascular application, low thrombogenicity, excellent biodegradability and bioresorbability. The degradation of Mg alloys which is one of the crucial parameters for biomedical Mg applications, were investigated in vitro and partially in vivo showing high potential for application.

In this special issue we summarize the state of the art with respect to Mg stents and osteosynthesis approaches. The material development and characterization as such is still a focus of research. The reason for this is that except for one example where the CE mark for biodegradable screws was issued Mg implants for bone applications are not in use, mainly due to the unacceptable high corrosion rate. In contrast to permanent implant materials all alloying elements and intermetallic phases will be released. At the moment little is known about how alloying elements and intermetallics influence cells or the human body in general. For cardiovascular application several "First in Man" studies are available. Here the safety demands are significant and approval will only be issued if it is proven that degrading metal implants under no circumstance provide a risk for embolisms or other lethal failures.

An overview of the demands and state of the art is given by Bartosch et al. [1] who address not only stents but also degradable heart valves in their review. They also consider how to compare in vitro and in vivo results in a predictive manner. A very interesting and innovative production technology for Mg-scaffolds is presented by Haffner et al.: Magnetron sputtering to achieve microstructured scaffolds [2].

J. Maier, a well-known expert in Mg physiology, complements this view by giving insights on how stents interact with the surrounding tissue and what the effects of high Mg concentrations on smooth muscle and endothelial cells are [3].

The central point all the papers deal with is the degradation of the material. How can we determine the degradation in the laboratory and how comparable are these results with the final observations in the living organism? We know that environmental conditions are crucial for the degradation of the materials and that the whole system is highly dynamic: changes in pH can stop or stimulate the degradation and influences the solubility of degradation products. The presence of salt ions can also accelerate the degradation while proteins can slow the process down. Just to mention a few of the multiple parameters which influence the degradation already in vitro. As regards the living system – such as cell culture or even in the body – the whole degradation process is rather unknown. Müller et al. [4] address this problematic by giving an overview of the electrochemical techniques used to determine the degradation in vitro.

While the chemical description of Mg and Mg-alloy degradation under (near) physiological conditions is complicated but hopefully to a certain extend also feasible, the understanding of the mechanisms is still rather limited when cells and the living organisms come into play. Here a variety of cell culture experiments are performed which elucidate either the influence of the degradation process on cells or their influence on the degradation. In this respect coatings come into play because the preparation of a perfect surface which hinders initial degradation and supports cell attachment and proliferation is the first crucial step for a proper implant integration. Several approaches are possible and in this issue Kluger et al. [5] chose hydroxyapatite as a well-described and biomimetic coating for Mg-alloys.

As mentioned above many aspects contribute to the degradation of Mg and its alloys. Among them of course the microstructure plays a significant role. This feature can be tailored by using alloying elements, heat treatments or processing steps like extrusion. It can also be influenced unintentionally, e.g. by the processing steps or the final sterilization process. Here Feyerabend et al. [6] present an overview on how typical sterilization techniques can influence several material parameters, among them degradation.

In this special issue we focused intentionally on in vitro approaches because we feel that what is currently

available in terms of animal studies or clinical trials is on a descriptive level rather than focusing on the fundamental understanding of mechanisms as we address in this special issue.

We hope that the selection of topics give a good introduction into the field.

Best regards
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