Mechanical loads and their influence on the strain and degradation behavior in degrading Mg10Gd

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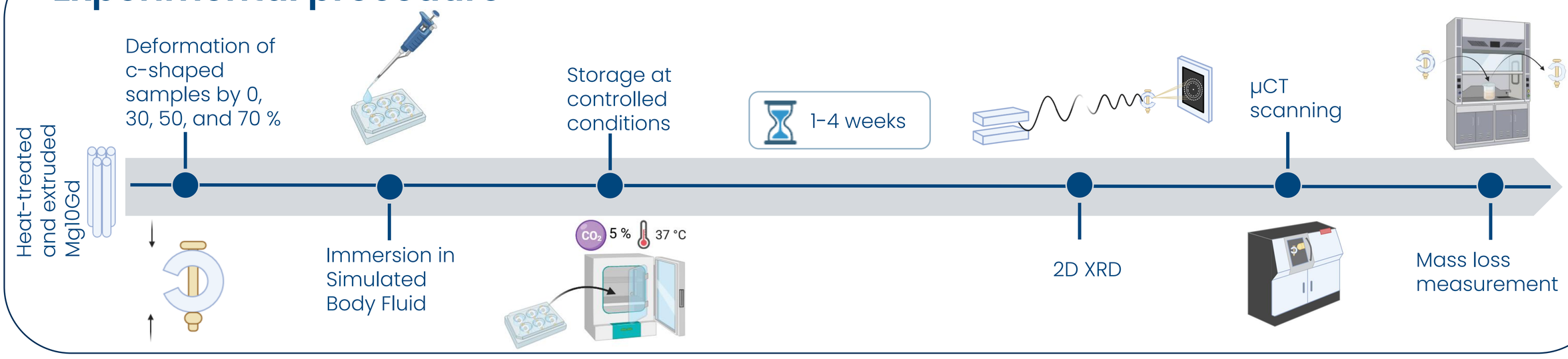
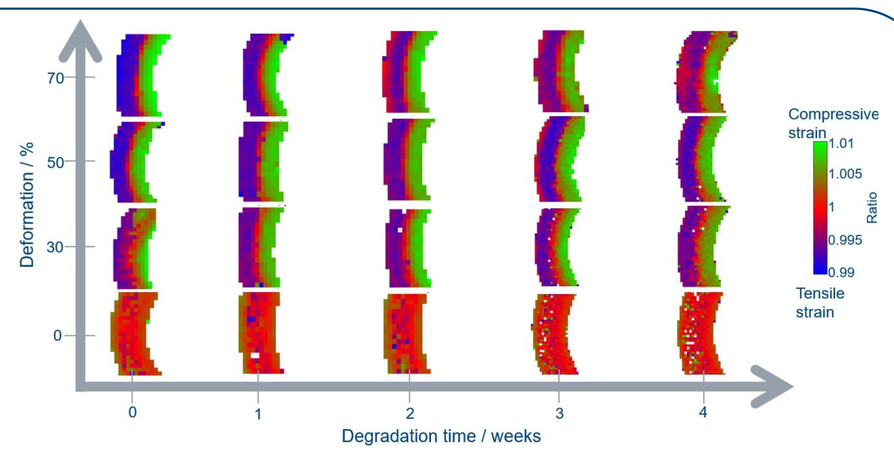
- Magnesium (Mg) as a biodegradable bone implant has been highly investigated
- Mg has similar mechanical properties as bone, is biocompatible and biodegradable meaning a second surgery is not necessary [1]
- Biodegradation is a complex process which is influenced by many parameters, e.g. the alloy composition, the surrounding medium, and mechanical loads
- Mechanical loads may induce a higher degradation which can lead to an early implant failure and a renewed bone fracture [2]
- To prevent this, it is crucial to understand the changes in the stress distribution during the degradation

Experimental procedure



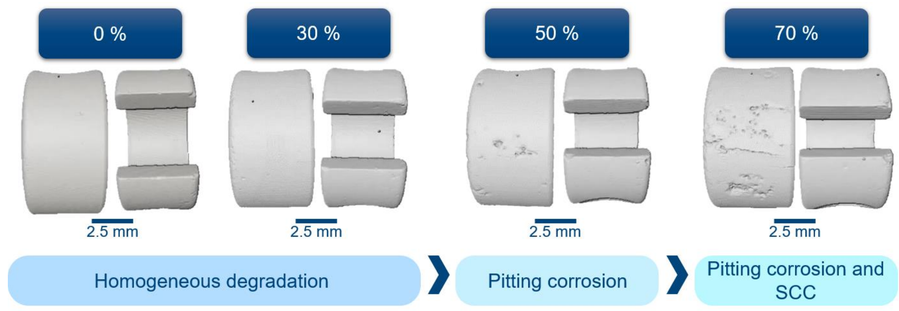
Strain distribution (2D XRD)

- No changes in tensile or compressive strain for deformations up to 30 %
- Reduced tensile strain visible for deformations of 50 % after 3 weeks of degradation
- For 70 % deformation, reduction in tensile strain is already visible after 2 weeks of degradation, while after 4 weeks a region of no stress indicates cracking



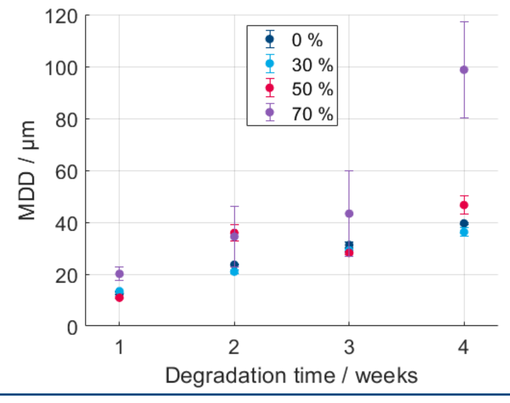
Degradation mechanism (µCT)

- Homogeneous degradation visible up to 30 % deformation for both tensile and compressive strains after 4 weeks
- At 50 % deformation, regions of tensile strain show pitting corrosion
- Additional stress-corrosion cracking (SCC) occurs at 70 % deformation



Degradation parameter (mass loss)

- The degradation can be quantified by etching away the degradation layer forming around the sample
- A linear increase in the mean degradation depth (MDD) is visible for up to 30 % deformation
- Higher deformations show an unpredictable and erratic evolution of the MDD



Results

- Deformation leads to shifts from homogeneous degradation to pitting corrosion and SCC in the case of Mg10Gd
- Changes in the degradation mechanism and reductions in strain only visible for tensile strains

→Interdependence between degradation and internal strains

References

[1] Willumeit-Römer, R. et al., DOI: 10.1007/978-3-319-72526-0
[2] Gao et al, DOI: 10.1016/j.actbio.2018.11.019
Images in experimental section: created with BioRender

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