Safety recipient for controlled selective laser melting of magnesium

S Böhringer[1], A Kessler[1], J Rüegg[1], R Schumacher[1], E Schkommodau[1], M de Wild[1]

[1] *University of Applied Sciences Northwestern Switzerland, School of Life Sciences, Institute for Medical and Analytical Technologies, Muttenz, CH*

INTRODUCTION: Additive manufacturing opens new perspectives towards novel implant shape and function. Technological progress has led to reproducible manufacturing of implants by selective laser melting (SLM) out of metallic materials like titanium[1] or NiTi[2]. However, only few attempts with magnesium (Mg) have been reported[3,4] aiming to resorbable implants. Due to the materials reactivity, the process of selective laser melting on Mg requires special precautions. In this study, we developed and validated a prototype for a safety recipient for the controlled operation inside a commercial SLM machine.

METHODS: In order to limit the reaction volume, a hermetic container was constructed in which the SLM process can be studied under a protective gas atmosphere inside an SLM Realizer 100 machine, see Fig. 1. The 100 W continuous wave Ytterbium-fibre laser with a wavelength between 1068 and 1095 nm passes a borosilicate glass on top of the container with negligible absorption. A Ti or Mg substrate serves as the building platform and is covered by a powder layer of controlled thickness.

Fig. 1: Safety recipient and building platform (ø65 mm) with selectively melted powder areas.

Experiments were first done with thin layers of Ti powder of approx. 30 µm thickness (Ti grade II, SLM solutions, Germany), later with atomized Mg powder (AZ91, SFM, Switzerland). The particle size distribution was determined (Helos, Sympatec GmbH, Germany). The particle shape and chemical composition were analysed by SEM/EDX (TM-3030Plus, Hitachi, Japan).

RESULTS: The used Mg powder has a d_{50}-value of 57 µm and the particle express a spherical morphology (Fig. 2) which is important for a good flowability. After passing the quartz lid, the laser beam accurately irradiates the powder bed on the building platform according to the predefined scan trajectories, see Fig. 3. Ti powder as well as AZ91 powder can be successfully fused to the substrate (Fig. 1 right and Fig. 3).

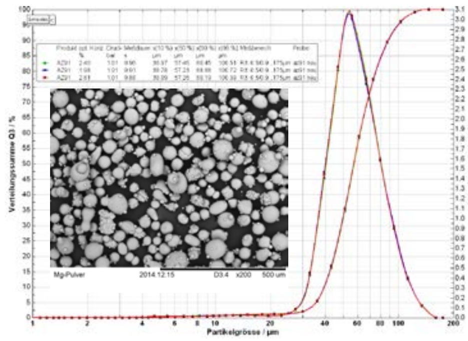

Fig. 2: Particle size distribution of the AZ91 powder, logarithmic scale from 1 µm – 200 µm. The inset shows a SEM image of the spherical particles. Scale bar 500 µm.

DISCUSSION & CONCLUSIONS: The developed safety recipient allows controlled experiments to study the SLM process of Mg powder with various substrates, types of powder, process parameters and environments (protective gas composition and pressure). Single SLM layers of Mg have been created.

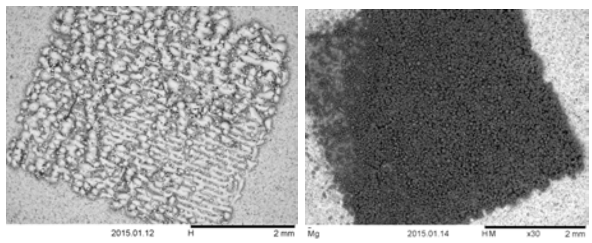

Fig. 3: Powder selectively fused to Ti substrate. Left: Ti powder, right: Mg powder. Bar = 2 mm.

REFERENCES: [1]H. Rotaru, et al (2015), Maxillofac Plast Reconstr Surg 2015 **37**:1;1. [2]W. Hoffmann et al (2014), J Tissue Engineering **5**:1-14. [3]L. Jauer et al (2013), Europ Cells and Materials **26**:Suppl. 5, 21. [4]C. Chung et al (2011), Rapid Prototyping Journal 17;6, 479–490.

ACKNOWLEDGEMENTS: This work was supported by the *stiftung***fhnw**.