3D structures by spark plasma sintering for efficient and sustainable tool manufacturing

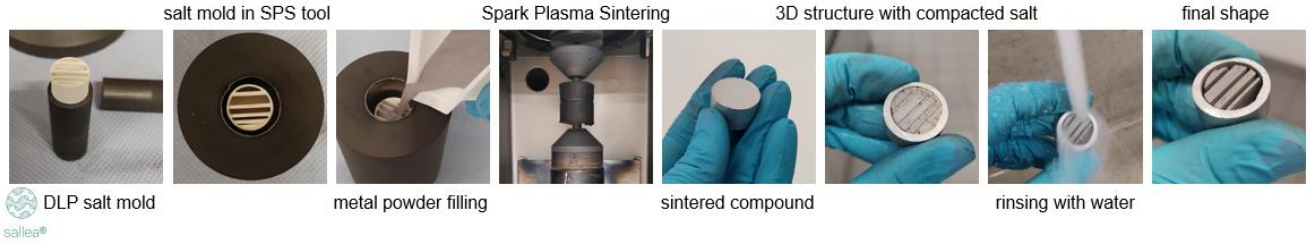
Bachelor / Semester / Master Thesis

The **Advanced Manufacturing Lab (am|z)** performs internationally leading research in the field of manufacturing engineering. A recent research focus is put on sustainable manufacturing and low-waste production. Near-net shaping of hard materials could benefit the tool making industry to become more sustainable. For a new industry related research project, we are looking for a motivated student.

Motivation

Hard materials shape the world. Tools for many manufacturing processes require high wear resistance and toughness. Consequently, such materials are intrinsically difficult to shape themselves. Today, these tools are cut from monolithic blocks, e.g., via spark erosion and grinding. The materials of interest are manufactured via powder metallurgy (PM), but most additive manufacturing methods are unsuitable because a) they work via the liquid phase (like e.g., laser powder bed fusion LPBF), or b) they yield porous bodies. Near-net shape methods involve processes like hot-isostatic pressing (HIP).

We aim to reduce manufacturing costs and waste by pre-shaping the partly finished components in a sintering process. For this purpose, spark plasma sintering (SPS) will be employed. This sintering technique usually yields cylindric semifinished parts that need to be further processed. In this project, you will work with space holders for pre-shaping sintered PM specimen, thus making the first steps towards developing a reproducible, near-net-shape 3D sintering process.



A new process for near net shaping components has recently been developed in collaboration between sallea, amlz and inspire. This process uses salt (NaCl) structures as space holder materials. As salt melts at ca. 800°C, this material is limited to sintering temperatures well below. To expand the applicability of this new 3D sintering process to materials like tool steels, Co-WC compound, or Ni-based alloys, other space holder materials need to be assessed.

In this project, the student investigates sintering properties of water-soluble ceramic materials. Subsequently, the dissolution characteristics will be analyzed. Furthermore, sintering characteristics of steels and a nickel alloy will be determined, and first co-sintering trials will be performed to show the compatibility of the materials.

Goal 1: Determine sintering and dissolution characteristics of water-soluble ceramic space holder materials with preferably an option for recycling or circular use of the space holder.

Goal 2: Determine options for porously printing the water-soluble ceramic space holder, with a focus on the process used by sallea.

Goal 3: Co-sintering and separation of demonstrator structures from at least one of the materials: steel, Ni-alloy, WC-Co compound.

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Tasks (to be scaled to the type of project and student background)

- Literature review of 3D SPS methods and water-soluble ceramics
- Solubility and sintering tests of ceramics at am|z
- Study on the printing of the water-soluble ceramic at sallea
- Specimen production of the water-soluble ceramic from powder to brown body at sallea
- Specimen production using a spark plasma sintering machine at am|z
- Specimen analysis (microstructure, density, geometrical accuracy)
- (Property determination (tensile strength, hardness, wear))
- Written report and presentations (interim and final)

Note: These tasks would be feasible for a master thesis, smaller work packages within this project can be found for a bachelor thesis/master project/semester project.

Peripherals

Interest in circular economy, materials science and analysis, and advanced manufacturing is required. A hands-on and experimental attitude is needed. No specific knowledge with manufacturing systems is necessary. Previous experience with water soluble ceramics is a plus.

Start

immediately or upon agreement

Contact

Please send your resume/CV (including lists of relevant publications/projects) and transcript of records or a short write up of your motivation and suitability for the project to.

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