Master Thesis Announcement

Re-use of Metal Powders for Additive Manufacturing Processes

Background
Selective laser melting (SLM) is an additive manufacturing process in which the thermal energy of a laser beam melts and fuses areas of the powder bed. This technology allows manufacture the near-net-shape components. In many cases only a small portion of the powder is actually melted and solidified into a component. Most is left after the build. Since the powder used in SLM is costly and waste should be avoided. The un-melted powder is therefore recycled and reused in the subsequent process. Due to the heating effect originated from the laser beam and the interaction with the surrounding atmosphere, the un-melted metal powder becomes aged gradually. Correspondingly, the surface morphology and chemistry, the shape and size distribution as well as the flowability of the particles are modified. The aged powders may affect the final properties of the printed component negatively, making the number of times that metal powder can be cycled in an SLM process limited. It is thus of great importance to establish relevant methods for estimating the utilization limit of the reused powder. From the economic point of view, it is also of urgent interest to develop a recycling methodology to reuse the metal powder.

Objectives
The objective is to a) Determine the utilization limit - “lifetime” of the initial powder material in the SLM process; b) Develop a methodology which is sensitive, reliable and easy enough to monitor the progress of the “lifetime” of the metal powder; c) Develop a strategy to reuse the metal powder by keeping the metal powder as close to the “virgin” condition as possible by certain post process steps.

Work Description
This work will be performed in close collaboration between Uddeholm, the world's leading manufacturer of tool steel, and the Department of Industrial and Materials Science at Chalmers University. The following packages are included:

- Literature study
- Simulate the aging process during SLM by heat-treating powder in a furnace with controlled atmosphere under certain time.
- Post processing of aged powder for recycling, e.g., by milling or reduction annealing
- Surface morphology and chemistry (Optical Microscopy, Scanning Electron Microscopy, X-ray diffraction, and X-ray Photoelectron Spectroscopy)
- 3D printing by SLM and material testing, e.g., impact toughness

Qualification
We are looking for you who are studying towards a Master of Science degree in the field of material science, applied physics or mechanical engineering.

Start of the thesis work:
Time frame: The thesis covers 30 credits / 20 weeks or 60 credits/40 weeks
Contact: Docent Yu Cao (yu.cao@chalmers.se); Academic supervisor and examiner Dr Christos Oikonomou (christos.oikonomou@uddeholm.com); Industrial supervisor