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Ph.D. (2014) in Materials Science and Metallurgy, University of Cambridge
Doctoral Dissertation: Design and modelling of ultra-high strength steels: nanoprecipitation and plasticity

November 2017 – present	Senior researcher, LPW Carpenter Additive, UK
November 2013 – November 2017	Postdoctoral researcher, TU Delft, Netherlands

- Data driven process optimisation in additive manufacturing.
  Powder recycling, SLM processing and atomisation.
- Novel alloy design for additive manufacturing.
  Via plasticity modelling.

POSTECH GIFT
Graduate Institute of Ferrous Technology

From powder to part: towards predicting properties of AM microstructures

Additive manufacturing (AM) has the potential to design new alloys based on unique microstructures obtained from unconventional processing routes. Typically, during the AM process, metallic systems experience very high cooling rates, undergoing localised liquid-solid followed by solid-solid phase transformations in fractions of a second. Infinite processing strategy and parameter combinations in AM will influence the local solute distribution, phase transformation kinetics and, ultimately, on the generation of microstructures.

Based on the current challenges and research opportunities around AM, there will be two aspects addressed in the talk: (i) mechanical response of AM-processed parts, and (ii) powder feedstock characterisation and powder evolution during recycling. The talk will be based on laser powder bed fusion (LPBF) processes.

The aim of this first part is to build the framework for a strengthening model that captures plasticity in AM-processed microstructures. A comparison between wrought and LPBFprocessed austenitic stainless steel 316L will be presented, where the differences in the microstructure will be used to explain the observed differences in mechanical properties. The processing-microstructure-properties in the LPBF-processed 316L will be described semiquantitatively.

In addition to establishing the processing-microstructure-properties relationship in AM, the powder feedstock and its characteristics also need to be considered. The second part of the talk will illustrate examples of how processing needs to be fine-tuned for a given set of feedstock characteristics. Furthermore, the degree of complexity is increased by considering a serial production scenario. Most studies in literature are limited to the effect of virgin powder feedstock on the part property. Nevertheless, in reducing costs during serial production, powder recycling becomes an attractive solution. Usually, the concentration of interstitials elements within the powder is known to increase as the powder is recycled. Changes in the chemistry therefore need to be accounted for in future builds. Examples include Ti-6Al-4V, IN718 and AlSiMg.

Such understanding of the above will ultimately provide a solid background in the design of future alloys tailored for the AM process.