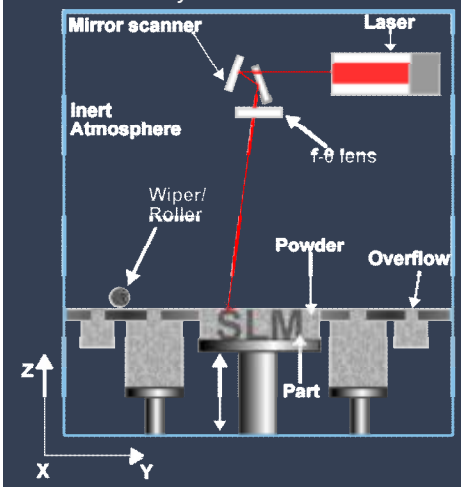
EPSRC Centre for Innovative Manufacturing in LASER-BASED PRODUCTION PROCESSES

Selective Laser Melting of Refractory Metals

Alfred T. Sidambe, Peter Fox (University of Liverpool)

Introduction

Selective Laser Melting (SLM) is a leading Additive Manufacturing technology that is used for high value low volume manufacturing. The development of material specific processing parameters has been driven by applications in the aerospace, automotive and medical sectors. Currently the technology is used commercially for the processing of Steel, Titanium, Nickel and Aluminium alloys.



Schematic overview of the SLM process

Refractory Metals

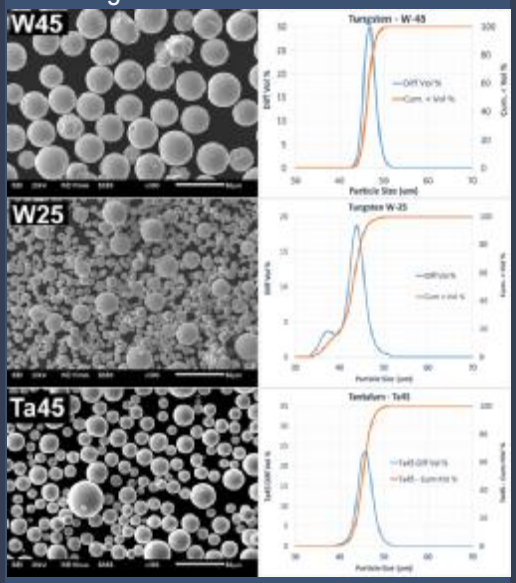
Refractory metals are high strength, high temperature and have excellent corrosion resistance. Applications today include medical implants, rocket nozzles and support hardware in the nuclear industry.

Project Aims

- To develop processing parameters for the main refractory metals and for alloys
- To identify any barriers that may limit the effectiveness of SLM processing and evaluate the performance
- To evaluate the impact of cellular refractory metal structures for industrial applications

Current Materials

- Tungsten and Tantalum



- SEM s showing highly spherical powders
- Sub 25 and 45µm particle size distribution

Equipment

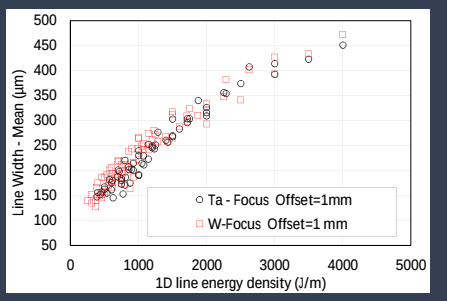
RENISHAW SLM 125 Machine

- Max. Laser Power - 200W
- Continuous Wave (CW)
- Max. Scan Speed – 2000 mm/s
- Laser Spot Diameter – 35µm
- Layer Thickness Range – 20 to 100 µm

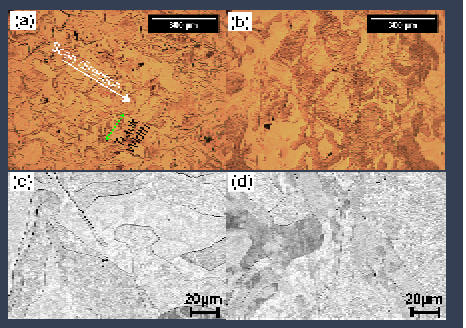
Material Development

- Manufacture of pure Tungsten, Tantalum and other refractory metals by SLM can be expected to encounter difficulties due to the high melting point, high thermal conductivity, high viscosity and oxidation sensitivity [1]. Development is carried out by melting over a wide range of laser power and scan speeds

SLM of single layer tracks (W45)

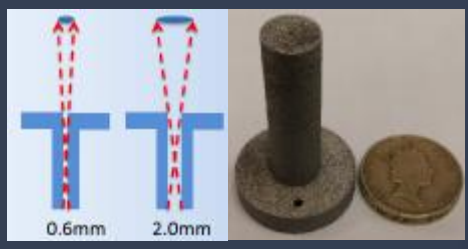


Grain structures of Tungsten SLM



Cross sectional (a) and (c) | Build direction (b) and (d)

SLM of Tungsten Collimator



SLM was used to fabricate a finer collimator which resulted in a narrower beam spot (0.6 mm nominal)

References

[1] Wauthle, R.; van der Stok, J.; Amin Yavari, S.; Van Humbeeck, J.; Kruth, J.P.; Zadpoor, A.A.; Weinans, H.; Mulier, M.; Schrooten, J. Additively manufactured porous tantalum implants. *Acta Biomater* 2015, *14*, 217-225.

RENISHAW apply innovation™

AWE

HERIOT WATT UNIVERSITY | UNIVERSITY OF CAMBRIDGE | MANCHESTER 1824 The University of Manchester | UNIVERSITY OF LIVERPOOL | Cranfield UNIVERSITY | EPSRC Engineering and Physical Sciences Research Council