Additive manufacturing of pure tungsten lattice structures by laser powder-bed-fusion process.

Miguel Zavala-Arredondo[1], Ahmed Tawfik[2], Neil Dickinson[3], Aaron Holt[3] Liam Blunt[2]

1- UKAEA, Culham Science Centre, Abingdon, OX14 3DB, UK
2- University of Huddersfield, School of Computing and Engineering, Huddersfield, UK
3- Holdson Ltd., Huddersfield, UK

Corresponding author: miguel.zavala-arredondo@ukaea.co.uk

Pure tungsten lattice components are currently being considered for use in conceptual fusion reactor designs due to their potential to customise thermal conductivity in shielding applications. As complex lattice designs are developed for high thermal performance, their manufacturability becomes a critical challenge that must be addressed to ensure repeatability of functionally optimised intricate tungsten parts. The present work investigates laser powder-bed-fusion (L-PBF) process parameters and in-process heat dissipation behaviour within the lattice geometry to control thermal stresses and reduce residual stress build-up during the build process. Simple modifications are proposed in existing lattice designs to avoid structural thermal distortion caused by features in the geometry. It is shown that by controlling the in-process thermal profile in complex geometries the build quality can be improved with higher repeatability of the build thus reducing waste and increasing AM process productivity. We conclude that L-PBF process parameters and in-process geometry-based thermal profile must be investigated in parallel to ensure that design for manufacturing (DFM) practices are properly applied at early stages in the development of new complex components. This suggests that geometry-based thermal profiles must be considered in future part qualification programmes.

In this study a Renishaw REN 500M equipped with reduced build volume (RBV) was used and the powder used is 15-45µm. The manufactured parts were inspected using Electron microscopy (SEM). The result of this experiment shows that small tungsten lattices with sub 650µm unit cell induce swelling phenomena, on the other hand larger unit cells namely 850µm unit cell reduce swelling and results in more repeatable lattice structure.