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Residual stress and heat treatment studies of additively manufactured stainless steel by neutron imaging and diffraction

Content

One of the biggest limitations of parts made by Selective Laser Melting (SLM) is the high tensile residual stresses that accumulate in the near-surface region. They are known to have a detrimental effect on mechanical properties and can even cause SLM process failure. Therefore, it is always needing to be applied additional heat treatment operations to relieve stress or shock peening to convert the tensile stress to the compressive stresses. Without the knowledge of residual stress in the material, it is not possible to estimate the service life or ensure the integrity of machine parts. Among various experimental techniques, only neutron and high-energy synchrotron X-ray techniques allow us to accurately measure the deep internal stress in large metallic samples with all stress components nondestructively. In this talk, we will discuss how neutron techniques are important for additive manufacturing or metallic materials research in general and present some of our residual stress characterization work performed on SLM build stainless steel which utilized both standard neutron diffraction and neutron Bragg edge imaging to investigate the effect of Hot Isostatic Pressing (HIP) temperature and heat treatment to the residual stress.

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Primary author(s) : Dr. MAIMAITIYILI, Tuerdi (Swerim AB)

Presenter(s) : Dr. MAIMAITIYILI, Tuerdi (Swerim AB)

Comments:

All authors: Tuerdi Maimaitiyili1, Sara Munktell1, Genoveva Burca2, Joe Kelleher2, Alexander Liptak2, Nuria Fuertes1, Leyla Wickstrom1, Konstantin Simonov1 and James Shipley3 ..... 1Swerim AB, 16440 Kista, Sweden; 2ISIS, Rutherford Appleton Laboratory, Harwell Campus, Didcot, OX11 0QX, United Kingdom; 3Quintus, 721 66 Västerås, Sweden

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