A Comparative Study of Microstructural Characteristics in Additive and Conventionally Manufactured Metallic Materials

Matjaž Godec[1]*, Črtomir Donik[1], Irena Paulin[1], Aleksandra Kocijan[1], Simon Malej[1], Bojan Podgornik[1], Stefan Zaefferer[2], Elena Tchernychova[1,3], Francisco Ruiz-Zepeda[1,3], Danijela Anica Skobir Balantič[1]

[1] Institute of Metals and Technology, Lepi pot 11, 1000 Ljubljana, Slovenia
[2] Max Planck Institute for Sustainable Materials, Max-Planck Strasse 1, Düsseldorf, Germany
[3] National Institute of Chemistry, Hajdrihova 19, 1000 Ljubljana, Slovenia
*matjaz.godec@imt.si

Additive manufacturing (AM) technologies have moved beyond the developmental stage and are now recognised as one of the methods for synthesising metallic materials, allowing the advantage of creating complex shapes. The most widely used method is laser powder bed fusion (LPBF), which enables the production of products with excellent mechanical properties. Additionally, artificial intelligence is increasingly being integrated into the field of additive technologies, allowing the modification of microstructures during the manufacturing process.

The unique microstructure formed in LPBF arises from rapid solidification, repeated melting, and multiple thermal interactions from the laser. While specific characteristics depend on the type of metal, certain trends can be observed. Columnar structures tend to form in the build direction, but these can be minimised or eliminated by adjusting process parameters, especially the laser scanning strategy. LPBF typically produces smaller crystal grains, which enhance mechanical strength and corrosion resistance.

The lecture will discuss various cases to highlight the advantages and disadvantages of the specific microstructures that form during the printing of metallic materials. We will cover stainless steel, aluminium alloys, nickel alloys and others. The microstructures of printed metallic materials will be compared with those of conventionally manufactured metals, focusing on mechanical and corrosion properties.