Advancing Surface Engineering in Additive Manufacturing of Metallic Materials

Matjaž Godec[1*], Danijela Skobir Balantič[1], Črtomir Donik[1], Aleksandra Kocijan[1], Francisco Ruiz-Zepeda[1,2], Bojan Podgornik[1]

[1]Institute of Metals and Technology, Slovenia
[2]Nacional Institute of Chemistry, Slovenia
matjaz.godec@imt.si

Abstract

In recent years, additive manufacturing processes have emerged as powerful techniques for synthesising various metallic materials, with methods like powder bed fusion and direct energy deposition leading the way. These cutting-edge processes have ushered in a new era of material production characterised by unique microstructures resulting from rapid solidification. These microstructures include dislocation substructures, distinct grain shapes, varying degrees of porosity, nano oxide particles, micro or nano segregations, and the accumulation of internal stresses.

In order to improve the corrosion resistance and wear properties of metallic materials, surface-hardening techniques like plasma nitriding have become increasingly popular. Among these techniques, plasma nitriding has proven to be highly effective in enhancing these important characteristics. However, when it comes to additive manufacturing, the relationship between the complex microstructures involved and the formation of surface compounds and diffusion layers during processes like plasma nitriding requires careful consideration.

Our presentation will show the results of plasma nitriding, specifically on stainless steel AISI 316L, maraging steel M300, and the nickel super alloy Inconel 625. We aim to reveal the differences in microstructure between the resulting compound and diffusion layers and compare them to materials produced through conventional methods. Additionally, we will investigate how different heat treatments affect the formation of nitride layers and provide detailed information through measurements of corrosion and wear. The cutting-edge additive manufacturing processes of laser powder bed fusion with advanced surface-hardening techniques present a promising path for optimising the properties of metallic materials.