## Surface Engineering - Applied Research and Industrial Applications
## Room Golden State Ballroom - Session IA-ThP

## Surface Engineering – Applied Research and Industrial Applications Poster Session

**IA-ThP-1 Metallurgical Coating by Laser Metal Deposition of H13 Steel Powder for Die Repairs*, Sheila Carvalho [sheila.m.carvalho@ufes.br],*** Federal University of Espirito Santo, Brazil*; Vagner Braga,* Bruning Tecnolometal Co., Brazil*; Rafael Siqueira, Kahl Zilnyk,* Technological Institute of Aeronautics, Brazil*; Johan Nuñes,* University of Sao Paulo, Colombia*; Reginaldo Coelho,* University of Sao Paulo, Brazil*; Milton Lima,* Institute for Advanced Studies, Brazil

The H13 tool steel is a typical hot-work material that exhibits superior thermal resistance, excellent hardness, and exceptional resistance to high-temperature fatigue and wear. This steel is also characterized by its high resistance to softening at temperatures below 540 °C and is extensively used to produce hot forging dies, hot extrusion channels, and high-pressure dies for low-melting-point metals such as aluminum and magnesium. Components made of H13 steel wear out over time and must be replaced, generating high costs and considerable environmental impact. One way to mitigate these problems is through repair using metallurgical coatings, which involve machining the worn area of the tool and depositing one or more layers of H13 steel using thermal means, notably with a laser beam. In this study, the microstructural and mechanical properties of H13 powder deposited via laser metal deposition (LMD) on H13 hot-work tool steel substrates were examined before and after heat treatment. Scanning electron microscopy (SEM), energy-dispersive X-ray spectroscopy (EDS), and electron backscatter diffraction (EBSD) were used to analyze the grain distribution, layer development, and carbide incidence. The mechanical properties were evaluated by Vickers hardness indentation tests. An α-ferrite matrix consisting of α'-martensite was identified along with a crack-free interface containing Mo- and Cr-rich precipitates between the cladded H13 steel and substrate. The EBSD results showed a highly consistent combination between the deposition and substrate, along with a structure consisting of columnar and equiaxial grains resulting from the directional solidification process. Wear resistance tests demonstrated that the H13-deposited region was in a better condition than the substrate because of the presence of martensite and carbides in the matrix, and the average wear decreased from $3.8 \times 10^{-4}$ $mm^3$/Nm to $0.5 \times 10^{-4}$ $mm^3$/Nm from the substrate to the laser cladding. The measured coefficient of friction for the die-repaired H13 rods did not undergo significant changes after laser cladding, with a COF of ~ 0.8. The average hardness levels of the substrate and deposition regions were determined to be 213 HV (α-Fe) and 671 HV (α'), respectively. The smooth transition in terms of hardness between the regions also indicates a tendency for lower stress concentrations. The results indicate that metallurgically coated H13 steel could be used to repair hot forming tools that extend the lifetime and decrease the discard of high-value components.

**IA-ThP-2 Effects of Cathodic Current Density on the Growth Mechanism and Corrosion Resistance of Micro-Arc Oxidation Coatings on AZ31 Magnesium Alloy*, Shih-Yen Huang [f08525129@g.ntu.edu.tw],*** *Chi-Hua Chiu, Yu-Ren Chu, Yueh-Lien Lee,* National Taiwan University, Taiwan

Despite decades of development, many growth mechanisms and properties of the micro-arc oxidation (MAO) process remain unclear, limiting further advancements in this surface treatment. Numerous studies have identified trends in MAO process parameters under specific conditions; however, altering these conditions often leads to varied results, highlighting the need for in-depth mechanistic studies. In this study, we address aspects of the formation mechanism of MAO under cathodic bias control. Preliminary results show that, while maintaining the electric current at a constant value, varying the cathodic current density significantly affects the microstructure and anti-corrosion properties of MAO coatings on AZ31B Mg alloy. Specifically, when the cathodic current density exceeds the anodic current density, a distinct cross-sectional microstructure develops, leading to a significant decrease in corrosion resistance. These findings demonstrate that the instantaneous cathodic current density critically influences the growth path of MAO coatings, altering their microstructure and, ultimately, their corrosion resistance.

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