#PLATH00013

ELABORATION OF 316L/CU COMPOSITE ALLOY USING A HYBRID PVD/SPS PROCESS

DEPOS - Plasma-assisted deposition, coatings and layers

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Abstract content

Powder metallurgy is an ideal field for developing advanced materials with complex geometries and compositions. Iron-based alloys produced through sintering often exhibit significant porosity. Adding small amounts of copper provides several benefits: it lowers the sintering temperature, eliminates pores due to its excellent wettability, reduces stress concentrations, and prevents microcrack formation. The localization of copper at the grain boundaries of steel powders enables the design of an alloy with a controlled microstructure, thus enhancing its mechanical performance (ductility, wear resistance, creep, and fatigue) as well as its resistance to corrosion and oxidation [1]. Several approaches can be employed: liquid copper infiltration into a compacted steel powder or the direct incorporation of copper into the steel powder before sintering as a binding agent. The innovative hybrid approach presented in this work, combines physical vapor deposition (PVD) and spark plasma sintering (SPS) processes. In this study, we investigate the development by SPS of a 316L alloy (particle size: 250-300 µm) with copper-enriched powder boundaries deposited by sputtering. Surface functionalization of the powders is performed using a custom-designed PVD chamber prototype (Fig. a) developed in-house with an original configuration [2]. This fabrication method ensures more precise control over the amount and distribution of copper at the powder grain boundaries, making it easier to achieve a more homogeneous material and enhanced optimization of its mechanical performance (fig. b). The influence of the copper layer thickness on the powders, regarding mechanical performance and the microstructure of the material after sintering, is analyzed. The mechanical behavior of the samples is evaluated using mechanical tests (tensile, compression, hardness,…). The microstructure and phase identification are studied via SEM, EDS, and X-ray diffraction (XRD).

References

[1] Wilbert D. Wong-Angel et al., Materials and Design 58 (2014) 12-18.

[2] Cédric R. et al., Materials science and Engineerging 139 (2020) 100521.

Fig 1. Diagram of the PVD deposit chamber

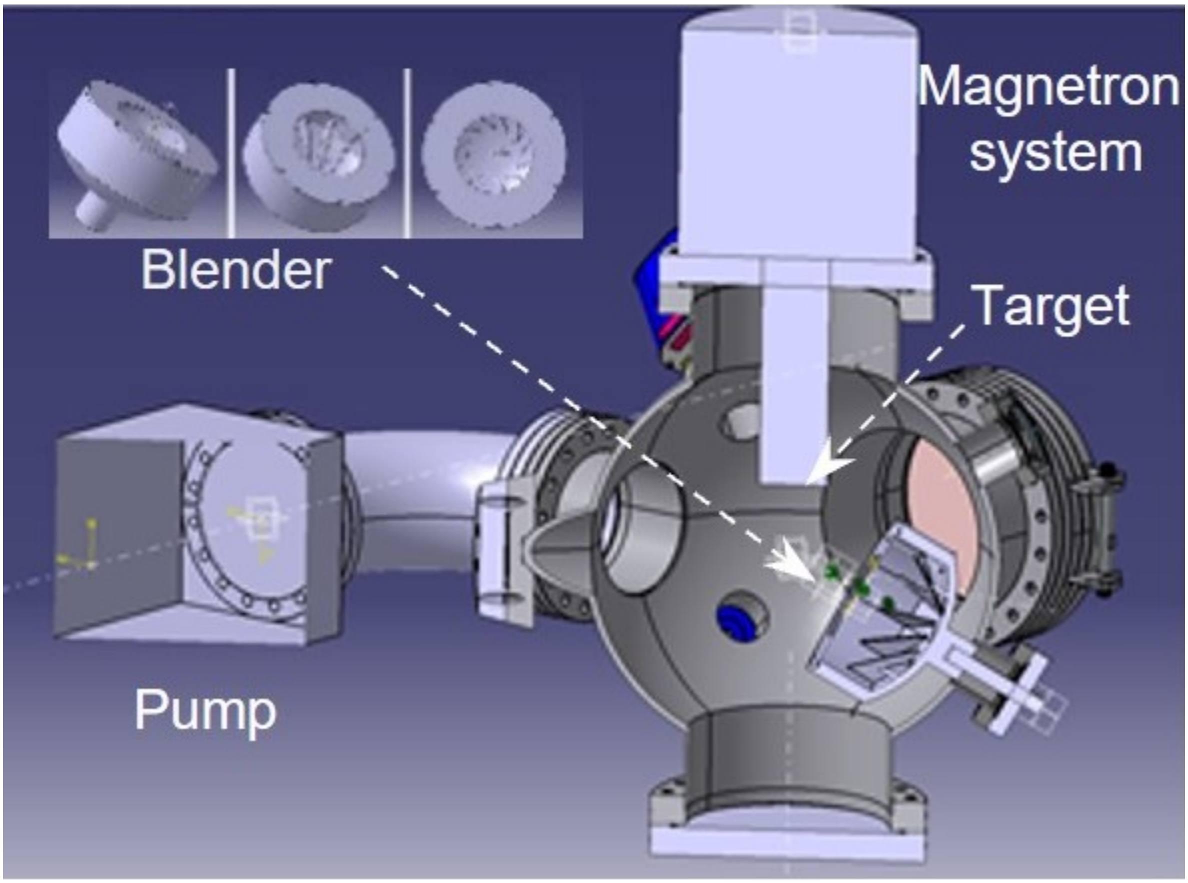

Fig 2. SEM image and Cu mapping after sintering