#PLATH00014

THERMODYNAMIC MODELING AND EXPERIMENTAL INVESTIGATION OF TI PVD COATINGS AS PROTECTIVE BARRIERS AGAINST CARBON DIFFUSION DURING SPS

DEPOS - Plasma-assisted deposition, coatings and layers

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Abstract content

The fabrication of metallic parts through powder metallurgy techniques, such as spark plasma sintering (SPS), represents a relevant alternative to conventional manufacturing processes. This technique enables the production of dense, high-performance materials with excellent mechanical properties in a single step. The powder is placed into a mold and densified through Joule heating and uniaxial pressure (Fig.1). One of the main challenges of the SPS process is the carbon diffusion from graphite tools and/or graphite foils in contact with the sintered powder. If carburization is not prevented, it can degrade material properties and lead to composition gradients at the surface [1]. In this study, titanium coatings (thicknesses ranging from 0.5 to 2 µm), deposited via PVD on graphite foils in contact with pure iron powder, proved to be effective in preventing carburization during sintering (1050 °C - 10 min - 70 MPa). However, coating thickness is a key parameter: a minimum thickness of approximately 1 µm is required for effective protection. The coating's stability and elemental diffusion at the coating/substrate interface were carefully analyzed using SEM-EDS and complemented by phase identification through XRD.Thermodynamic simulations using DICTRA (ThermoCalc®) confirmed the experimental findings (fig.2), enabling the prediction of optimal thicknesses and the selection of new elements (Ti, Zr, Hf, Ta, W) as diffusion barriers against carbon, due to their ability to form carbides with low carbon diffusion coefficients. This study is part of the ANR OEDIPUS project (ANR-23-CE08-0028).

References

[1] M.R. Ardigo-Besnard et al., Solids 2(4) (2021) 395-406.

Fig.1 Diagram of SPS process

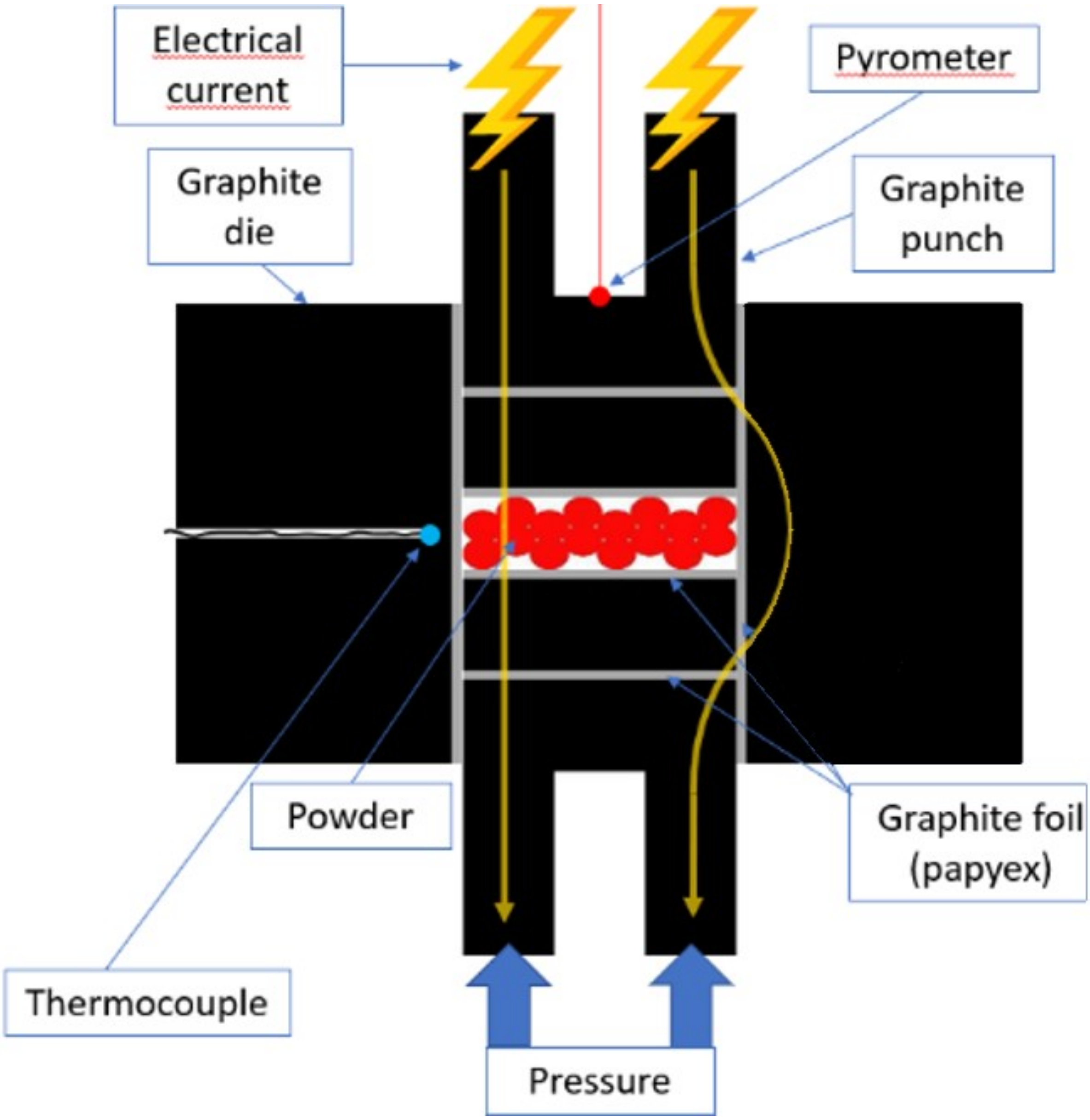

Fig.2 Simulation of a 1 µm thick Ti film at 1000°C