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Tantalum based coatings deposited by HPPMS as an alternative to protect stainless steel bipolar plates in PEMFC

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A proton exchange membrane fuel cell (PEMFC) converts hydrogen and oxygen gases into electricity with water as the only by-product. Due to its high efficiency and zero emission, PEMFC is of great interest as a clean energy device beyond petroleum. The PEM drive electric vehicles are currently a technological reality but several components durability and fabrication costs, like bipolar plates, must be optimized for widespread commercialization.
The bipolar plate material must be chemically stable, highly electrical and thermal conductive; have low contact resistance with the backing, good mechanical strength, low gas permeability and inexpensive massive production. Stainless steel (SS) is considered one of the most promising candidates for transport applications but its chemical stability in PEMFC environment must be optimized to ensure an adequate lifetime.
The aim of this study was to investigate the performance of Tantalum (Ta) based coatings deposited on SS by High Power Pulsed Magnetron Sputtering technique (HPPMS). HPPMS is a recently developed ionized physical vapour deposition technique (i-PVD) characterized by the deposition of uniform, extremely dense and well-adherent coatings. The utilization of HPPMS for the deposition of protective coatings for bipolar plates in PEMFC has never been reported. Tantalum nitride (TaN) coatings grown at different N2-to-Ar ratios and an innovative coating based on Ta and ITO layers were deposited by HPPMS. Ex-situ electrochemical tests and interfacial contact resistance (ICR) measurements were conducted in PEMFC environment to evaluate the protection of these coatings for SS bipolar plates. The electrochemical testing was carried out under different applied potentials (up to 1.4VSHE), pH values and test durations (up to 180 min) in order to mimic the real operational conditions of a PEMFC.

Keywords
Tantalum
HPPMS
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corrosion