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Magnetron sputtering for corrosion protection of liquid cyclotron target for Fluorine-18 production

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Chemically inert coatings on Havar® entrance foils of the liquid cyclotron targets for Fluorine-18 production are needed to decrease the amount of ionic contaminants released from Havar®. For efficient corrosion protection, both chemical inertness and microstructure of the coating are important. The corrosion damage of coated entrance foils is caused mainly by the diffusion of highly reactive products of water radiolysis through the protective film toward Havar® substrate. Since amorphous metal alloys (metallic glasses) are well known to perform a high corrosion resistance, the glass forming ability, microstructure and diffusion barrier efficiency of binary alloys containing Nb, Ta, Zr were investigated. Preliminary study of the co-sputtered Nb–Ta, Nb–Zr and Ta–Zr films of different alloy composition was realized in order to define the glass forming abilities. Though co-sputtered Nb–Ta and Nb–Zr alloy films of different contents were crystalline, Ta–Zr alloy was found to form amorphous microstructures in a range of composition with 30–73% atomic Ta. Diffusion barrier efficiency tests used reactive aluminum underlayer and protons of HCl solution as corrosion inducing particles. The diffusion barrier efficiency of Nb–Zr and Nb–Ta alloy coatings decreased with increase of Nb content. The diffusion barrier efficiency of sputtered Ta–Zr alloy coatings increased with the transition from nanocrystalline columnar microstructure to amorphous for coatings with 30–73 at.% Ta. In the next step, the properties of TaZr (1:1) protective films deposited from mono-target by magnetron sputtering were studied. The deposition parameters were optimized in order to provide dense amorphous coating with minimal level of intrinsic stress. The TaZr (1:1) coating is to be sputtered onto planar Havar® foils for Fluorine-18 target of IBA CYCLONE 18/9.

Primary author: SKLIAROVA, Hanna (LNL)

Co-authors: Dr AZZOLINI, Oscar (LNL-INFN); Dr JOHNSON, Richard (Best Theratronics Ltd); CISTERNINO, Sara (LNL); PALMIERI, Vincenzo (LNL)

Presenter: SKLIAROVA, Hanna (LNL)

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