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P3.211 Electrochemical techniques as innovative tools for fabricating divertor and blanket components in fusion technology

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Electrochemical techniques such as electroplating of metals, electrochemical machining (ECM), electroforming, anodizing and electropolishing of metal surfaces have been established successfully in a variety of industrial processes. A wide range of applications are available such as the electrodeposition of decorative metal coatings on plastics and metals, corrosion protection of mass products like steel sheets, and the electrodeposition of high electro-conductive coatings in electrical industry. The main advantages of these electrochemical processes are good controllability of coating thicknesses, their cost-effectiveness and their good scalability from scientific settings to industrial scale.
However, for applications in fusion technology material development needs to meet unique and specific restrictions or requirements, e.g., low activation, high heat-flux properties, corrosion resistance to liquid metal alloys, e.g., Pb-15.7Li, T-permeation reduction and suppression of MHD effects. Therefore, uncommon materials like tungsten, CuCrZr, RAFM-steels have to be processed for which available standard electrochemical processes show various limitations at the moment.
To overcome these limitations, electrochemical methods were introduced to divertor and blanket component manufacturing that led to promising electrochemical techniques contributing their inherent advantages to a variety of applications. An example for such developed processes is the ECX process, which is based on the electrodeposition of aluminum from ionic liquids, to fabricate corrosion barriers on RAFM steels that are resistant against corrosion in flowing Pb-15.7Li. Others are the electrodeposition of metals (Cu, Pd, Ni) on tungsten and CuCrZr substrates for joining applications and the surface microstructuring of tungsten surfaces by ECM in first wall applications.
This paper provides an overview on these processes (ECX, electrodeposition on W and CuCrZr, ECM) and describes the achieved benefits of using electrochemical material processing technologies for applications in fusion technology. Additionally, potentials for transferring these processes onto industrial scale will be highlighted and provide implications for future directions of scientific research and development.

Presenter: LORENZ, Julia (Institute for Applied Materials Karlsruhe Institute of Technology)

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