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Pulsed Laser Deposition of Fe-Based Metallic Glasses with Enhanced Mechanical Strength and Corrosion Resistance

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Abstract : This study explores the synthesis and characterization of Fe-Cr-Mo-Co-C-B-Si thin film metallic glasses fabricated using the pulsed laser deposition (PLD) technique on silicon wafers and 304 stainless steel substrates. We systematically varied the laser pulse numbers (20,000; 30,000; 40,000) and energies (130, 165, 190 mJ) to investigate their effects on the microstructural, mechanical, and corrosion properties of the deposited films. Comprehensive characterization techniques, including grazing incidence X-ray diffraction, field emission scanning electron microscopy, atomic force microscopy, and transmission electron microscopy with selected area electron diffraction, were utilized to assess the amorphous structure and surface morphology. Results indicated that increased pulse numbers and laser energies led to enhanced deposition rates and film thicknesses. Nanoindentation tests demonstrated that the hardness and elastic modulus of the amorphous thin films significantly surpassed those of the 304 stainless steel substrate. Additionally, electrochemical polarization and impedance spectroscopy revealed that the Fe-based metallic glass coatings exhibited superior corrosion resistance compared to the stainless steel substrate. The observed improvements in mechanical and corrosion properties are attributed to the unique amorphous structure achieved through the PLD process, highlighting the potential of these materials for protective coatings in aggressive environments

Keywords : silicon wafer, laser energies, corrosion resistance, Fe-based metallic glass
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