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Corrosion of amorphous and nanocrystalline Fe-based alloys on the synergistic effect of NaCl and H_2SO_4

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Abstract –Amorphous $Fe_{78}Si_{13}B_9$ and $Fe_{73.5}Si_{13.5}B_9Nb_3Cu_1$ ribbons were prepared and nanocrystalline $Fe_{73.5}Si_{13.5}B_9Nb_3Cu_1$ ribbons were obtained by annealing process. A comparative study of the electrochemical corrosion behaviors of $Fe_{78}Si_{13}B_9$ and $Fe_{73.5}Si_{13.5}B_9Nb_3Cu_1$ amorphous and nanocrystallized alloys were performed by linear polarization method and electrochemical impedance spectroscopy (EIS) in the corrosive media (NaCl and H_2SO_4 solutions). The influence of heat treatment on the alloys structure and corrosion resistance was investigated. The results show that the crystallization of amorphous ribbons occurs in two steps, nanocrystalline alloys have a higher corrosion resistance than amorphous alloys, while the corrosion resistance of amorphous and nanocrystalline alloys increases as thermal treatment temperature rises. In addition, H^+ have a higher corrosion resistance than Cl^-.

Nanostructured Fe-based alloys have softer magnetic properties, such as larger saturation polarizations and magnetic permeabilities, smaller anisotropies and coercive fields and vanishing magnetostrictions, than their precursor alloys in the amorphous state. However, The influence of factors connected with corrosion on the softer magnetic properties is almost impossible to eliminate. The aim of this work has been the systematic study of the corrosion resistance of amorphous and nanocrystalline Fe-based alloys. All the tests were carried out with the same material in different states: amorphous, nanocrystalline and crystalline.

In this study, amorphous $Fe_{78}Si_{13}B_9$ and $Fe_{73.5}Si_{13.5}B_9Nb_3Cu_1$ ribbons were prepared by the chill block melt-spinning process and nanocrystalline $Fe_{73.5}Si_{13.5}B_9Nb_3Cu_1$ ribbons were obtained by annealing. The amorphous ribbons and their crystallization processes were identified by differential scanning calorimeter (DSC) and X-ray diffraction (XRD). A comparative study of the electrochemical corrosion behaviors of $Fe_{78}Si_{13}B_9$ and $Fe_{73.5}Si_{13.5}B_9Nb_3Cu_1$ amorphous and nanocrystallized alloys was performed by linear polarization method and electrochemical impedance spectroscopy (EIS) in the corrosive media (NaCl and H_2SO_4 solutions). The photographs of the samples after potentiodynamic polarization were observed by SEM. The influence of heat treatment on the alloys structure and corrosion resistance was investigated. The results show that the crystallization of amorphous ribbons occurs in the two steps, nanocrystalline alloys have a higher corrosion resistance than amorphous alloys, and the corrosion resistance of amorphous and nanocrystalline alloys increases as thermal treatment temperature rises. In addition,H^+ have a higher corrosion resistance than Cl^-.