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Effect of hydrogen addition on the mechanical properties of Zr-based metallic glass

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Abstract

In this study, correlation between the softening phenomenon and free volume content in hydrogenated $Zr_{57}Al_{10}Cu_{15.4}Ni_{12.6}Nb_5$ amorphous metal through instrumented nanoindentation tests and differential scanning calorimetry (DSC) analysis is reported. X-ray diffraction analyses revealed that hydrogen addition gives rise to the development of large void structures that facilitate the local atomic displacement. The mechanical characterization using nanoindentation showed that hydrogen addition may induce the softening of Zr-based metallic glasses even for high Zr content. The shear softening of $Zr_{57}Al_{10}Cu_{15.4}Ni_{12.6}Nb_5$ ribbons is attributed to the weakness of atomic cohesion due to the squeezing and mobility of hydrogen atoms. The resistance to hydrogen embrittlement combined with high thermal stability may increases the possibilities of potential use of $Zr_{57}Al_{10}Cu_{15.4}Ni_{12.6}Nb_5$ amorphous alloy as good metal membrane.

Key words: hydrogenation; nanoindentation; differential scanning calorimetry (DSC); free volume; softening

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