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Recently, metallic glass (MG) membranes that are permeable to hydrogen have gained interest due to the increasing importance of hydrogen separation in a number of applications, e.g., hydrogen-powered fuel cells. An important issue in the context of MG membranes is the hydrogen-induced embrittlement and efforts to understand the role played by hydrogen in the mechanical properties, especially yielding and plastic deformation behavior, of MGs are being made. In this study, therefore, an attempt was made by performing nanoindentation tests with cube-corner and spherical indenter tips on a series of Ni–Nb–Zr amorphous alloy ribbons to investigate the hydrogen effects on nanohardness and pop-in behavior (Figure 1). Weight gain measurements after hydrogen charging and thermal desorption spectroscopy (TDS) studies (Figure 2) were utilized to identify how the total hydrogen is partitioned into mobile and immobile parts. These, in turn, indicate the significant role of hydrogen mobility in the amorphous structure on the mechanical properties. In high-Zr alloys containing immobile H, both hardness (*H*) and shear yielding stress (τ_{max}) increase significantly; while in low-Zr alloys having only mobile hydrogen, decrease in hardness and τ_{max} were noted (Figure 1). The changes in shear transformation zone (STZ) volume, estimated through cumulative analysis of τ_{max}, caused by hydrogen absorption were also found to depend on hydrogen mobility such that immobile hydrogen reduces the STZ volume while mobile hydrogen increases it.
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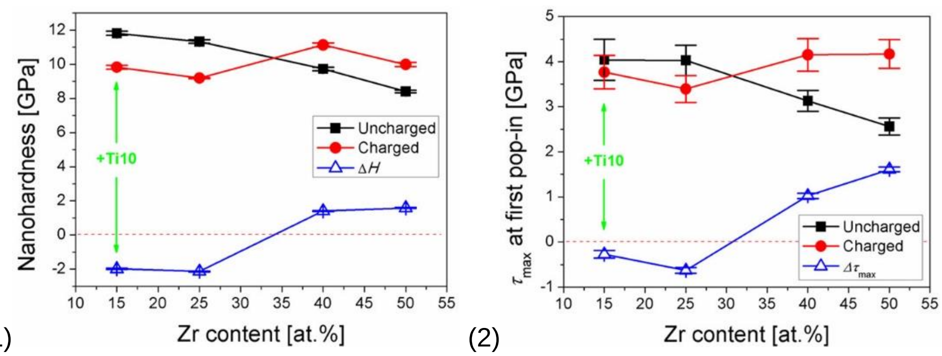

(1) (2)

Figure 1. Variations in (1) hardness (H) obtained from cube-corner nanoindentation and the hydrogen-induced change (ΔH), and (2) the maximum shear stress (τ_{max}) at the first pop-in obtained from spherical nanoindentation and the hydrogen-induced difference ($\Delta\tau_{max}$) with Zr content. The data of Zr15Ti10 are identified as "+Ti10".

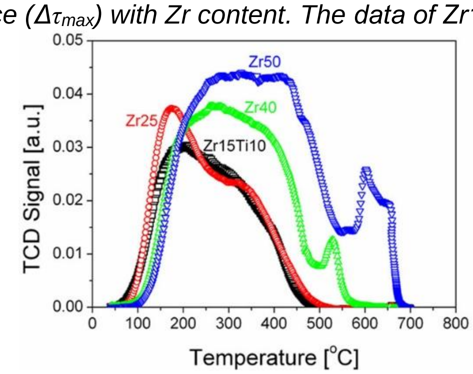

Figure 2. Plots of hydrogen thermal desorption acquired by TDS measurements of the charged alloys.