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Effect of hydrogen on the damping properties of NiTi alloys

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Abstract

The effect of hydrogen dopings on the internal friction and the Young's modulus has been investigated in the alloys $Ni_{50.8}Ti_{49.2}$, $Ni_{49}Ti_{51}$ and $Ni_{40}Ti_{50}Cu_{10}$ as a function of the hydrogen content n_H (n_H=H/Me atomic) and frequency. It has been found that hydrogen strongly affects the anelastic spectrum of these alloys in the temperature domain. The IF peak occurring at the austenite-martensite (A-M) transition in the solubilized $Ni_{50.8}Ti_{49.2}$ alloy is enhanced by hydrogen at low contents (n_H<1.3) and reduced at high hydrogen contents (n_H > 1.3). An additional IF peak is introduced in the same alloy by H for n_H>1.3. This second peak, which appears at temperatures higher than the martensite start temperature M_s, is likely due to hydrogen re-distributions over subsets of interstitial sites within a hydride, under the applied alternating stress fields associated with the sample vibrations. The relaxation parameters of this peak, which is thermally activated, are in keeping with the expectations from H diffusion high temperature data.
In the aged alloy $Ni_{49}Ti_{51}$ H suppresses the low temperature IF background and introduces a thermally activated relaxation, which is associated with H dragging processes by twin boundaries. A relaxation effect, again ascribable to H dragging processes by twin boundaries, has also been evidenced with the $Ni_{40}Ti_{50}Cu_{10}$ alloy.
The most remarkable result of these investigations is the fact that hydrogen appears to be a very sensitive tool to probe twin boundary dynamics.