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Strain Variation during Isothermal Martensite Transformation under Stress in the $Ti_{40.7}Hf_{9.5}Ni_{41.8}Cu_8$ Alloy

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Shape memory alloys can recover unelastic strain during heating (shape memory effect) or unloading (pseudoelasticity effect). This behavior is due to thermoelastic martensitic transformations – the first-order phase transitions that occur during temperature or stress variation. If the transformations take place on cooling under a stress, the oriented martensite appears that is accompanied by a strain increase. On subsequent heating this strain completely recovers during the reverse transition.

It has been found that in some NiTi-based shape memory alloys, isothermal formation of the martensite phase can be observed. Moreover, it has been shown that during isothermal holding under a constant stress, the isothermal martensitic transformation is accompanied by variation in reversible strain. Before holding, the samples have been cooled under the stress, however, the sample can be cooled to the holding temperature without stress and then to be subjected to loading and holding under a stress. The aim of the present work was to study the influence of regimes before holding to the reversible strain variation during isothermal martensitic transformation in the $Ti_{40.7}Hf_{9.5}Ni_{41.8}Cu_8$ alloy.

To study the isothermal strain variation in the $Ti_{40.7}Hf_{9.5}Ni_{41.8}Cu_8$ alloy, two series of experiments were carried out. In the first one sample was loaded up to 240 MPa at holding temperature equals 75 °C or 100 °C, held for an hour, unloaded and heated. In the second series, a sample was cooled under 240 MPa to the holding temperature, kept at a constant temperature for an hour, and then heated. The holding temperatures were chosen from 29 °C to 44 °C, which was within the range of the forward transformation under stress.

The results obtained showed that during isothermal holding of the $Ti_{40.7}Hf_{9.5}Ni_{41.8}Cu_8$ alloy under stress an increase in strain occurred in both regimes. The strain was completely reversible upon subsequent heating. In the first regime, the maximum isothermal strain of 3.8% was observed at a temperature of 75 °C. In the second regime, the maximum isothermal strain was 3.2% and it was found at a temperature of 40 °C. Thus, the results of the study showed that the regimes of the sample cooling before holding (cooling under a stress or cooling without stress and loading) hardly affect the isothermal strain but they significantly influence the holding temperature at which the maximum recoverable strain is observed.

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