Acoustic emission study of Ti-25Nb and Ti-25Nb-1.0O shape memory alloys in the initial stage of tensile deformation

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ABSTRACT

This work is focused on the analysis of acoustic emission (AE) experimentally measured in the initial stage of tensile loading (up to 2.5% of strain) of two shape memory alloys (SMAs) with compositions Ti-25Nb and Ti-25Nb-1O (at. %). The underlying deformation mechanisms of the SMAs considered in this study are different. In the case of Ti-25Nb SMA, the initial tensile deformation is governed by a long-range-ordered stress-induced martensitic transformation from β to α″ phase [1]. The apparent yield stress of the Ti-25Nb SMA is around 180 MPa. In the case of the Ti-25Nb-1O SMA, the underlying deformation mechanism is high-order-like (continuous) strain glass transition associated with nanosized modulated domains (nanodomains) caused by randomly distributed oxygen atoms [2]. As a consequence, the Ti-25Nb-1O SMA shows a nonlinear superelastic behavior with small hysteresis and the apparent yield stress is around 400 MPa. The difference between the underlying deformation mechasmins and resulting mechanical behaviors of the SMAs was clearly observed in the recorded AE signals especially in terms of the number of counts. The number of AE counts measured at specific stages of tensile loading of the Ti-25Nb SMA was significantly lower, than that of the Ti-25Nb-1O SMA. Moreover, as the purely elastic deformation does not generate any AE, the recorded signals can succesfuly serve to identify the onset and track further development of the stress-induced transformations in Ti-25Nb and Ti-25Nb-1O SMAs during tension.

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