ICAM 2009
11th International Conference on Advanced Materials
Rio de Janeiro Brazil
September 20 - 25

Superelasticity Behaviour in Stress-Electrical Resistivity-Strain Coupled Tests on Cu-Based Shape Memory Single Crystals

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Abstract – Superelastic behaviour of shape memory alloys single crystals has been investigated by the electric resistivity measure technique coupled simultaneously during traction tests. Samples in austenitic phase were submitted to stress induced martensite (SIM) under several conditions such as: different temperatures, different deformation rates, successive martensitic transformations and different crystallographic orientation axes. Electrical resistivity versus strain curves presented a linear relation without hysteresis and independence on temperature. In the case on the increasing of deformation rates, these curves show a little hysteresis due to adiabatic transformations. For samples submitted to successive transformations, Electrical resistivity curves showed changes with induced martensite types. In samples of the same alloy with different crystallographic orientations was observed that single variant martensite nucleation presented distinct values, this characterizes martensite electric resistivity anisotropy.

In this work was realized a study of the electromechanical properties behaviour during superelastic tests conducted on Cu-Al-Be and Cu-Zn-Al shape memory alloy single crystals under distinct conditions. Mechanical behaviour results were compared with those obtained by the electrical resistivity change tests and with others obtained in literature [1]. Summarizing, coupled stress-strain with electrical resistivity measures in superelastic tests showed that electrical resistivity versus strain curves depend directly on the inducted martensite quantity, independent on temperature and without hysteresis (figure 1). In the different strain rates tests can introduce a hysteresis loop in the electrical resistivity curves since the reactions aren't adiabatic [2]. Moreover, electrical resistivity curves are affected by the mechanisms which interfere in the displacement of the austenite/martensite interface during martensitic transformation, for example in blocking (or pinning) of interface displacement due to quenched supersaturated vacancies [1]. In figure 2 electrical resistivity curves show different measures and slopes for each martensite type in the successive transformation tests (transformation sequence: $\beta_1 \Leftrightarrow \beta_1' \Leftrightarrow \alpha_1'$) [3]. In the different crystallographic orientations tests was demonstrated martensite single variant electrical anisotropy, in this case independent on chemical composition for each β_1' martensite variant. These coupled tests results indicate the susceptibility of the electrical resistivity measures in the studies and developments of shape memory effect and martensitic transformation.

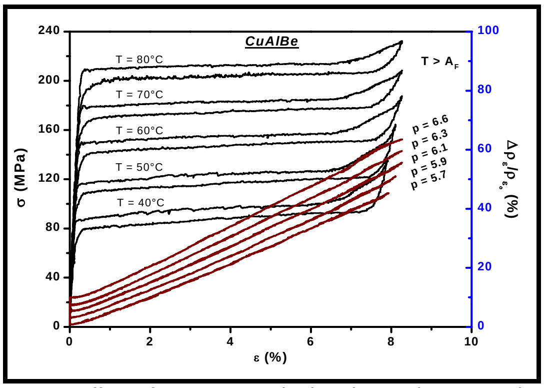

Figure 1. Effect of temperature in the electro-thermomechanical properties of the superelastic tests (CAB10).

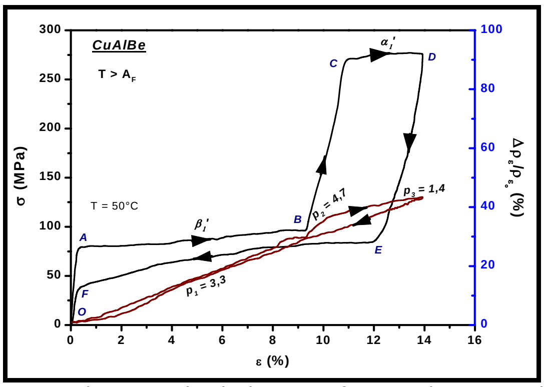

Figure 2. Electro-mechanical curves of successive martensitic transformation in the CAB5 sample.

References

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