Thermodynamic Study of the Martensititic Phase Transformation in Cu-Al-Ni Shape Memory Alloys

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A thermodynamic study based on high sensitivity adiabatic calorimetry of the first order martensitic transformation undergone by Cu-Al-Ni shape memory alloys is presented. By using the specific heat data, a careful analysis of the various contributions to the specific heat in these alloys is performed. The harmonic, anharmonic, and electronic contributions have been estimated from the experimental data of the metallic components. The knowledge of the crystal lattice contribution provides an accurate baseline for the thermodynamic analysis of the martensitic phase transformations as a function of the thermal history of the alloy. This study has permitted a careful estimation of the phase transition temperature of each martensite plate as a function of its stored elastic energy. Within this frame, the distribution density of the elastic energy states in the martensitic phase is directly derived from the specific heat data. It also permits a simple analysis of the nucleation processes and gives a convincing explanation for the temperature memory effects also present in these alloys after partial transformation cycles. Complementary optical observations of the martensitic transformation are in good agreement with the calorimetric results.