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Elastic properties of invar $Fe_{64}Ni_{36}$

L. Nataf, F. Decremps, G. Syfosse, M. Gauthier

Institut de Minéralogie et Physique des Milieux Condensés, CNRS & Université P. et M. Curie (Paris, France)

lucie.nataf@pmc.jussieu.fr

Since its discovery in 1897 by C.E. Guillaume, invars has been the subject of numerous theoretical and experimental studies [1]. All these works agree to relate the invar effect, anomalous low thermal expansion over a wide temperature range, to magnetoelastic properties. However, a detailed microscopic explanation still remains puzzling for scientists.

We have made simultaneous x-ray diffraction and ultrasonic measurements [2], up to 7 GPa at ambient temperature on a polycrystalline sample of $Fe_{64}Ni_{36}$. We found a linear variation with pressure of the bulk modulus B with an abrupt discontinuity at 3.1 GPa. The slope dB/dP goes from an unusual low value (1.4) to a regular one (3.6). This result can be interpreted using the 2γ-state model [3] : up to 3.1 GPa, a gradual population of the low spin-low volume state at the expense of the high spin-high volume one compensates the thermal expansion due to the anharmonicity of the lattice vibrations.

References:

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