Phonons in FCC-Fe precipitates in Cu

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An fcc-Fe is stable only at temperature between 1185K and 1667K. However, Fe precipitates which are grown in supersaturated Cu-Fe solid solution retain fcc structure even at room temperature. The lattices of Fe precipitates are coherent with Cu matrix. At low temperature (T<70 K), Fe precipitates undergo a structural phase transition. The lattice structure in the low temperature phase is described by the shear wave propagating along the [110] direction and the [1-10] polarization vector. In related to the structural phase transition, drastic softening of the elastic moduli C ' and C11 is observed below 150 K.

The purpose of the present experiments is two points. There are no experimental data of phonon dispersion relation of fcc Fe at the room temperature because of no bulk specimen. Thus, the first purpose is to observe the phonon peaks and to determine the dispersion relations of fcc Fe at room temperature using the coherent precipitates. If observation of phonons is possible, the second purpose is to observe the phonon softening towards the structural phase transition.

A super-saturated Cu97Fe3 single crystal was grown by Bridgmann method. The sample was quenched into water from 1000 C, then precipitation anneal was performed at 600 C for 53.5 hours. Averaged precipitation particle size is estimated to be 50 nm. Phonon measurements were performed at the T1-1 triple axis spectrometer.

For small q regions, it was impossible to separate the phonons of Cu matrix and Fe precipitates. At high q regions, phonon intensity is too weak to observe because of small effective volume of fcc-Fe precipitates. However, we succeeded to observe phonon peaks of the [1 1 0] T1-branch at room temperature. Since the elastic modulus C ' shows softening towards the structural phase transition, to study the phonon dispersion relation of the [1 1 0] T1 branch would be interesting. Temperature variation of phonon peaks for fcc-Fe precipitates studied at q=0.3 is given in Fig. 1. At low temperature, phonon peak intensity is too weak and it is hard to discuss the phonon softening. However, phonon peak shift with temperature decreasing (hardening) between RT and 150 K is very large. The reason is considered to be increasing of mis-fitting parameter of the lattices between Cu and Fe precipitates. We would like to discuss this point thoroughly.

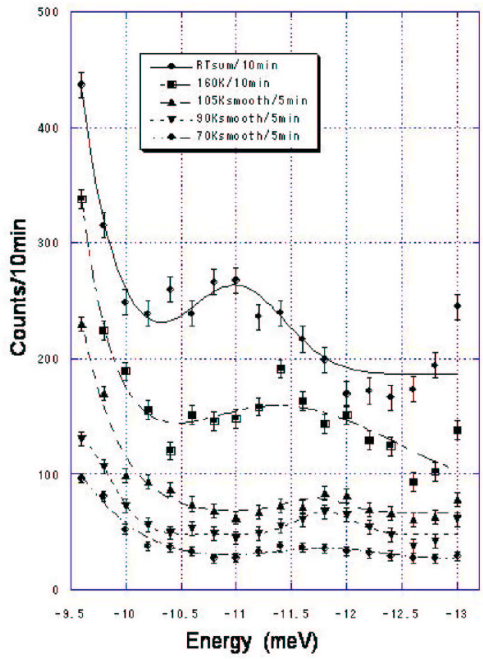

Fig. 1. Fig.1 temperature variation of phonon peaks of fcc Fe precipitates studied at q=0.3.