

Non-linear acoustic phonon dispersion anomaly in iron-manganese-based Elinvar alloys

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(The experiments were canceled for the problems with the reactor operation and sample preparations.)

Invar and Elinvar phenomena are of great scientific success in the application of structural materials to improve various safety problems. Also in recent years, further updates on the performance were reported in iron-manganese-based alloys, in which the temperature coefficient of Young's modulus is, at least, 10 ppm per K around room temperature by adding a small amount of the third impurity element, such as molybdenum [1, 2]. The so-called "super Elinvar" characteristics may be due to the combination of normal hardening and additional softening(s) in the materials. However, the mechanism of the softening has not been identified. To approach this fundamental problem in solid-state physics, we focus on a pioneering neutron work by Endoh *et al.*; they found a shallow anomaly in a transverse acoustic phonon dispersion around the Γ point in a similar Fe-Mn alloy [3]. The phonon anomaly can be observed only in the Γ_3 mode and indicates structural instability in the system. This experimental proposal aims to clarify the phonon anomaly in Elinvar alloys and the effects of impurity.

Single crystalline samples were prepared through the Bridgeman method [4]. The crystal orientation was checked through the Laue method, as shown in Fig. 1. To remove the mechanical stress, the sample was annealed at 1173 K for 2 h, and then slowly cooled to room temperature. The size of the sample is about 3mm x 1mm x 1mm.

Trial neutron experiments with the small sample were canceled for the unplanned shutdown of the research reactor and are pending. Since the size of the single crystalline sample may be too small to observe phonon excitations, we are continuing to prepare a large single crystalline

sample. (#22537)

[1] T. Masumoto, S. Ohnuma, K. Sugawara, and H. Kimura, *Mater. Trans.* 58, 701 (2017).

[2] K. Sugawara, S. Ohnuma, and T. Masumoto, *Mater. Trans.* 59, 897 (2018).

[3] Y. Endoh, Y. Noda, M. Iizumi, *J. Phys. Soc. Jpn.* 50, 469 (1981).

[4] Y. Umemoto, Doctor thesis (Tohoku University, 2023).

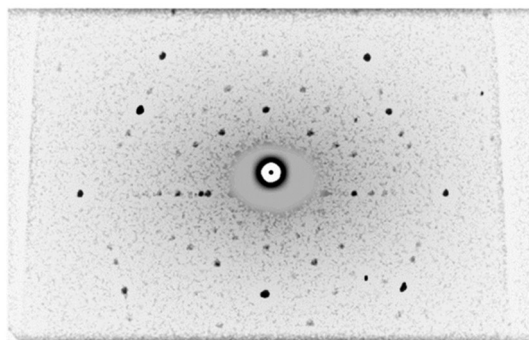


Fig. 1 A Laue photo of an Fe-Mn-Mo alloy.