Nature of diffuse scattering in a medium-entropy alloy

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(The experiments were pending for the problems with sample preparations.)

Short-range ordering phenomena have attracted attention in the frontier of material science with high-entropy alloys (HEAs). In particular, the impact of chemical/compositional short-range ordering on the mechanical strength of CrCoNi becomes a controversial topic in the research field of HEAs [1]. In our preliminary results, we found that a medium-entropy alloy MnCoNi shows diffuse scatterings around the forbidden reflection point, indicating short-range ordering of aniso-atom pairs [2].
This experiment aims to observe diffuse scattering signals in selected Brillouin zones for evaluating short-range order parameters in quenched MnCoNi and CrCoNi samples. Since we failed to grow large single crystalline samples of MnCoNi and CrCoNi, the experiments were canceled and are pending.

Here we report alternative results of the annealing effect in MnCoNi and CrCoNi polycrystalline samples. Figure 1(a) shows the neutron scattering profiles of the annealed (red), as-quenched (open black) MnCoNi, and annealed CrCoNi (grey) samples. For MnCoNi, the broad signals around the (100) forbidden reflection point are reshaped into relatively sharp peaks after the annealing at 673 K, indicating the development of a long-range tetragonal phase. As a result, the diffuse scattering may be due to the staggered alignment of constituent atoms, such as Mn-Ni. In addition, we found that the sharp components can be developed in a limited temperature and time region [Fig. 1(c)]. The qualitative feature of the structural transformation in the MnCoNi sample can be interpreted with a time-temperature-transition diagram. On the other hand, there is no change in the profile of the annealed CrCoNi sample. As a next step, we plan to grow a single crystalline sample and evaluate short-range order parameters of MnCoNi and CrCoNi samples.

[1] R. Zhang *et al*., Nature 581, 283–287 (2020).
[2] Y. Umemoto *et al*., Mater. Trans. 64, 2018 (2023).

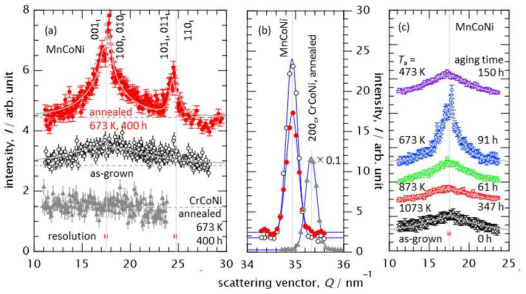

Fig. 1 Neutron scattering profiles of MnCoNi and CrCoNi samples measured at 6G-TOPAN. Data were cited from ref. 2.