CoPt alloy undergoes disorder-order transformation from a cubic disordered phase to a tetragonal ordered phase at 1045 K. Because of decrease in crystal symmetry, three ordered variants are formed. An ordering heat-treatment under a magnetic field was performed to control formation and selection of preferred variant with its tetragonal c-axis parallel to the applied magnetic field. However, the ordering process and mechanism of variant selection have not been clarified yet because of its multi-scale changes of microstructure over nm to µm scale. In the present work, multi-scale microstructure observation with the novel SEM was carried out using the channeling contrast imaging techniques to clarify the process of microstructure formation and variant selection in single crystalline CoPt alloy ordered by the two-step heat-treatment under a magnetic field of 10 T and without magnetic field. In order to understand the origin of various contrasts in the obtained SEM images, TEM and STEM observations were carried out and studied correspondence between SEM, TEM and STEM results.

In the early stage of growth process, many \{10\overline{1}\}_{110} \text{L10} twins were successfully observed in SEM observations and the contrasts of channeling BSE images well corresponded to TEM observation results in nm scale (Fig. 1). In addition, the variant which has c-axis parallel to the applied magnetic field was developed preferentially compared to other two variants. After all of the heat-treatment process, those twins were vanished and single variant structure was obtained. On the other hand, without magnetic field, coarsening process of the micro-twins in the early stage of growth heat-treatment was strongly limited because of competition among three variants. In addition, it was clarified by wide-range observation with SEM that the three variants formed self-accommodation structure of \{10\overline{1}\}_{110} \text{L10} twins (Fig. 2) which was similar to that in thermoelastic martensitic transformation. These results indicate, after the diffusional ordering process in the early stage, invariant deformation process becomes dominant and three variants accommodates martensite-like structure.

In this work, we successfully evaluated the microstructure development process of disorder-order transformation in single crystalline CoPt alloy in multi-scale by SEM observations with channeling contrast imaging technique. These results show promising performance of the novel SEM in multi-scale evaluation of microstructures.

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Fig. 1: (a) Channeling BSE image and (b) TEM bright field image for the specimen heat-treated at 773 K for 30 min under magnetic field of 10 T and at 1023 K for 3 min in the first and second steps, respectively.

Fig. 2: Channeling BSE image for the specimen heat-treated at 773 K for 30 min under magnetic field of 10 T and at 1023 K for 180 min in the first and second steps, respectively.