Grain refinement is known as effective way to obtain outstanding combination of strength and ductility. Among grain refinement techniques, reverse transformation is highly interested in ferrous alloys. Therefore this study is aimed to clarify microstructure change during reverse transformation in Fe-high Ni alloys with lath martensite structure in terms of mechanism of reversion, morphology and crystallography. Austenite reverse transformation from lath martensite structure was studies in Fe-high Ni alloys with 11, 18 and 23 Ni (mass %). In-situ observation by means of confocal laser scanning microscope (CLSM) and in-situ EBSD were carried out to direct observation. Orientations of austenite and martensite were characterized by using EBSD measurement. Morphological details of reversed austenite was characterized by electron channel contrast imaging (ECCI) equipped with FE/SEM.

It was found that Ni content is an important factor to define reversion mechanism, while it changes from martensitic reversion in Fe- 18 and 23 Ni to massive type reversion in Fe-11 Ni. Regardless of reversion mechanism, when there is K-S orientation between reversely formed austenite and initial martensite, austenite memory is found which leads to preservation of grain boundaries and orientation of prior austenite. After completion of martensitic reversion, by further holding, recrystallization is happen by nucleation and growth mechanism throughout orientation of recrystallized austenite is different with un-recrystallized reversed austenite.

Reversion in intercritical annealing region changes the chemistry of constituent phases. During intercritical annealing of Fe-18 Ni at 873 K, at the early stage, a lamellar structure consists of precipitated austenite and initial martensite is formed. By further holding, large white area (single phase austenite) is formed and grows very fast at the expense of lamellar structure without any specific orientation relationship. By applying deformation, mechanism and kinetics of reversion does not change, however the austenite recrystallization kinetics following reversion is accelerated by prior deformation lead to enhancement refinement of reversed austenite. Martensite recrystallization does not occur prior to reversion because deformation structure is appeared even after the reversion is completed.
In order to clarify the effect of intermetallic precipitation on the reversion, Fe-Ni-Mn alloy is selected as a model system. It is found that reversion behavior is strongly affected by heating rate in this alloy. Substantial structural refinement happens by reversion of very fine austenite from preliminary precipitate and austenite recrystallization.