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Dislocation structure analysis by neutron diffraction during tensile deformation in 18Ni martensitic steel

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Role of dislocation structure on work hardening behavior of quenched and tempered martensitic steel has not been clarified. Change of dislocation structure during tensile deformation in ultra-low carbon 18Ni martensitic steels in the as-quenched (AQ) condition and the quenched-and-tempered (QT) condition were analyzed using in situ time-of-flight neutron diffraction combined with the Convolutional Multiple Whole Profile (CMWP) procedure. Tensile test was carried out in a stepwise manner with unloading to get diffraction profiles with good statistics for the line profile analysis. The AQ sample showed a low elastic limit and a high tensile strength, whereas its dislocation density hardly changed through tensile deformation. On the other hand, the QT sample showed higher elastic limit and lower tensile strength than the AQ, whereas its dislocation density increased with the increase of strain. The dislocation arrangement parameter that represents the interaction among the dislocations was high before deformation and decreased (showing the weak interaction changes to the strong one) during deformation in the AQ sample, while the parameter was kept in a low value during the whole deformation in the QT sample. The ratio of screw and edge components was also analyzed, and should be responsible for discussing together with the dislocation density and the arrangement parameter to explain the work hardening behavior in martensitic steel.

Keywords: martensitic steel; dislocation density; dislocation arrangement; neutron diffraction; work hardening behavior

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