Precise phase quantification with respect to preferred texture orientation under the influence of an applied stress or strain is the most important characterization step to establish optimum manufacturing processes for high strength and better formability of the transformation induced plasticity (TRIP) steel in applications for the automobile industry. Phase transformation behavior of retained austenite to martensite in TRIP advanced high strength steel (AHSS) has been extensively investigated with two-dimensional X-ray diffraction (2D XRD). Distribution of applied stress partitioned in individual crystals also has to be determined to clarify the maximum driving force for $\gamma$-austenite to $\alpha'$-martensite transformation. Although the Rietveld refinement method provides reliable volumetric percentage of retained austenite, this method sometimes highly underestimates the effect of preferential orientation on the intensity of a specific X-ray reflection. It is also believed that individual components having different crystal orientations respond differently to the applied stress.

In this study, high yield strength TRIP steels are uniformly strained under biaxial tensile stress. The retained austenite volumetric ratio at each strain level is compared with the results from magnetic saturation measurements based on intensity integration of reflected individual crystal planes using 2D XRD. Residual intragranular stress relative to the reflected crystalline plane is also quantitatively compared as a function of the applied biaxial strain based on $\sin^2(\psi)$ analysis. To better understand the relationship between dislocation mobility and straining energy for phase transformation, the density of dislocation at each strain level is evaluated with the modified Williamson-Hall method. This study addresses that macro-scale $\gamma$ to $\alpha'$ transformation could be completed at a level of 10 % strain with randomly distributed micro-scale $\gamma$, suggesting that multi-composite mechanical behavior would be a main mechanism in deformation of TRIP steel.

Key words: two dimensional X-ray diffraction (2D XRD), transformation induced plasticity (TRIP), advanced high strength steel (AHSS), austenite ($\gamma$), martensite ($\alpha'$)