Evaluation of the mechanical property of ferrite lamellar in pearlite microstructure

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Pearlite microstructure in steels consists of lamellae of ferrite and cementite and their thicknesses are at an order of sub-micrometers. Single-phase specimen of cementite is known to be brittle, while the flow stress level of ferrite at R.T. with a specimen size larger than millimeter is of an order of few hundred MPa and elongation is larger than 20%. Strong yet ductile property of pearlite steels is considered to originate from the combination of these phases with largely different mechanical characteristics. One requisite property for the higher plastic flow stress level of the pearlite is the increase of the flow stress in ferrite, while the ductility of pearlite is realized when the cementite phase could deform into plastic range [1][2]. We recently tried to understand this phenomenon with a hypothesis that ferrite lamella sandwiched by cementite lamellae showed higher yield strength and strain hardening [3]. The results were that cementite lamellae could deform well beyond the elastic range when the yield stress and strain hardening of ferrite layers were high enough. In this communication, we use crystal plasticity finite element method to analyze slip deformation in ferrite lamella sandwiched by cementite layers. Densities of statistically stored and geometrically necessary dislocations are obtained and these quantities are utilized to evaluate mechanical response of ferrite layers with various thicknesses. Obtained results show notable increases in the yield stress as well as strain-hardening ratio of the ferrite layers when the layer thickness decreases.

References

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