Heterogeneous microstructure and enhanced mechanical properties in annealed multilayered IF steel

The microstructure and mechanical properties have been studied in interstitial free (IF) steel samples consisting of compression-bonded alternating layers of initially either cold-rolled (CR) or recrystallized (AR) material. After compression bonding followed by cold compression, the microstructure of the initial CR layers is characterized by a fine boundary spacing, while the boundary spacing in the initial AR layers is greater. Annealing of this compression-bonded sample is carried out at 600 °C to achieve a highly heterogeneous microstructure. During the early stages of annealing, coarsening is more pronounced in the CR layers leading to a more rapid reduction in the stored energy than in the AR layers. Further annealing results in recrystallization taking place preferentially in the AR layers with the consequence that the slowly recrystallizing CR layers are considerably harder than the AR layers. Tensile testing demonstrates that in this multilayered microstructure combinations of high strength and comparatively high ductility are achieved in the samples annealed at 600 °C for either 1 h or 1.5 h, when the microstructure is strongly heterogeneous with a large difference in the fraction of recrystallized material between the initial CR and AR layers. Such samples with alternating hard and soft layers are found to have a better combination of strength and ductility than other IF-steel samples with a more homogeneous microstructure. The enhanced strength in the annealed multilayered compression-bonded samples can be attributed to the influence of mechanical constraints between the layers.