ABSTRACT

Bake hardening (BH) is a phenomenon where the strain aging is exploited in a positive way to improve the strength of formed automotive components. To measure the BH effect during the experiments, the samples are subjected to a tensile strain of 2% at room temperature, unloaded, aged at the required temperature (usually 170 ^{o}C) for the necessary time (usually 20 minutes) and then strained again in tension until failure. The difference between the lower YS after aging and the flow stress at 2% prestrain is the BH effect.

The current study was intended to investigate the BH response in different grades of steel, as a function of various parameters. Physical model based on the theory of strain aging and data-driven artificial neural network based models were developed in order to investigate the science behind such phenomenon as well as to predict the BH response under different situations. Bainitic transformation leaves higher than equilibrium carbon in bainitic ferrite and generates large amount of dislocations. This fact was exploited to induce BH response in novel TRIP-aided steel.

Different characterization techniques were used to critically analyse the experimental results on the effect of various parameters on BH in different automotive steels. Some interesting observations, *e.g.* inducing BH response in IF steel by changing the processing condition, were made. The physical model can very accurately predict the BH response for many different experimental cases. Contribution of Cottrell atmosphere and the precipitation towards the final BH response can be quantified and predicted with the help of this model. Outcomes of such calculations were logical and self-consistent. Data-driven neural network based models can effectively predict the experimental results for a large number of datasets. It was found that these ANN models can be used to predict the BH response for a wide range of composition as well as processing variables. However, when the prediction range is too far from the dataset value, the models show less confidence in prediction by incorporating large error bars. Kinetics of bainitic transformation was studied with different characterization techniques including XRD, 3-DAP *etc.* It was found that the dislocations generated during the bainite transformation can be exploited to induce the BH response in TRIP-assisted steel without providing any external predeformation.