HIGH-STRENGTH STEELS FOR AUTOMOTIVE APPLICATIONS STUDIED USING HIGH-ENERGY X-RAY DIFFRACTION

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The current drive within the automotive industry towards increasing weight reductions and improved lifetime of key vehicle's components has triggered the development of a new generation of high-strength multiphase steels. The presence of relatively small amounts of metastable austenite (<20 vol.%) embedded in a complex multiphase steel microstructure exerts a significant effect on the mechanical properties of these materials. We have probed the mechanical response of high-strength metastable steels at different length scales by performing in-situ high-energy X-ray diffraction experiments at the beam lines ID11 and ID15A of the ESRF. The availability of dedicated optics at these beam lines to change the micro-beam dimensions has allowed us to assess the behaviour of the constituent phases in the steel microstructure on an average scale and at the level of individual grains in the present of different thermo-mechanical stimuli. In this contribution, results on two high-strength steels will be presented:

(1) low-alloyed TRIP steels: these materials are promising candidates for attaining significant auto body weight reductions by using thinner metal sheets, due to their outstanding combination of high strength and formability. We have monitored the transformation of metastable austenite grains into martensite for increasing tensile stresses and selected temperatures in the range of 100-300 K. The observed austenite grain stability has been correlated to local microstructural parameters such as the local carbon content and the grain size. The austenite stability and the evolution of the multiphase microstructure in terms of texture changes and stress partitioning have been correlated to the mechanical response of the material at the macroscale.

(2) high-carbon steels: these materials are currently being used for automotive ball bearings applications. We have studied in-situ the austenite transformation kinetics into lower bainite at selected temperatures in the range of 468-498 K, by continuously recording the diffraction patterns on a two-dimensional detector as a function of time. The observed transformation has been correlated to the low-temperature creep phenomenon in these materials. We have found that the transformation kinetics is accelerated significantly in the presence of an applied tensile stress of 250 MPa.