Processing of new dual-phase (DP) and complex-phase (CP) steels for automotive applications by tailored hot forming routes

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Abstract. Advanced high strength steels (AHSS) are being used in the automotive sector with the aim of supporting the current demands of reducing vehicle weight and structures, but cold forming of such steel grades shows some challenges like springback, high press forces or low stretch-flangeability. To overcome these drawbacks, different ferritic-martensitic dual phase (DP) alloys and martensitic-bainitic complex phase (CP) alloys with retained austenite were designed and novel hot forming routes were applied for processing them. The thermal cycle for the DP alloys included an intercritical reheating whereas in-situ austempering or slow continuous cooling preceded by supercritical reheating was used for the CP alloys. The objective of obtaining similar, or even better, post-formed mechanical properties than the current cold-formable DP1000-Low Yield and CP1000 grades in terms of yield strength (YS), ultimate tensile strength (UTS) and total elongation (TE), combining the new alloys and the proposed hot forming routes was investigated through an intensive testing campaign. First, cold rolled alloys were subjected to hot forming cycles including deformation levels up to 20% in a Gleeble machine and then formability tests at high temperatures (hole tensile tests, omega-shaped parts manufacture) were conducted to compare their performance against the current cold formable alloys. The promising results after hot press forming (YS ≈ 650 MPa; UTS ≈ 1150 MPa; TE ≈ 10% for DP alloys and YS ≈ 850 MPa; UTS ≈ 1250 MPa; TE ≈ 7% for CP alloys) pave the way to promote the use of these new alloys that will allow designing vehicle components with increased geometric complexity while minimizing the springback effect and reducing the press forces and the material scrap inherent of cold stamping.

Keywords: Hot Forming, Alloy Design, Dual-Phase Microstructure, Complex-Phase Microstructure, Mechanical Properties