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Effect of molybdenum on the strengthening mechanisms of advanced HSLA-steels

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The production and use of conventional, cold-rolled, high-strength low-alloy (HSLA) steels is well established in different markets. HSLA steels are characterized by a low-carbon alloying concept and therefore have excellent weldability. Different strength classes and good local formability enable a wide range of applications. The global automotive steel specification VDA239-100 currently defines grade CR460LA as the highest cold-rolled HSLA steel. Hot-rolled HSLA strip is standardly available with a minimum yield strength of up to 700 MPa. A simple transfer of such hot rolled HSLA concepts to cold rolled strip production is not possible.
The aim of this work was to extend the yield strength level of cold-rolled HSLA steels to above 500 MPa. Therefore, two chemical compositions based on a low-carbon concept were micro-alloyed with niobium while the second variant was additionally alloyed with molybdenum. The industrial production of the hot rolled coils took place at voestalpine Stahl GmbH. Afterwards different cold rolling degrees and annealing conditions were simulated in the laboratory to assess the influence of different strengthening mechanisms. The annealed samples were characterized using tensile testing and microscopy.
The results demonstrates that the addition of molybdenum leads to solid solution strengthening, an optimized precipitate and grain refinement strengthening and a largely suppression of recrystallization. This increases the yield strength by 30- 80 MPa for all conditions. Low cold reduction degrees and low annealing temperatures additionally leads to more robust process conditions in different final annealing treatments. For that reason, the use of low-carbon steels with niobium and molybdenum alloying in combination with established processing technologies for hot rolling, cold rolling and annealing is ideally suited for advanced HSLA steels.

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