Effects of hot forging on the shape and size of prior austenite grain in HS 6-5-2 high-speed steel

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Abstract:

Microstructure analysis was performed on rolled bars of high-speed steel after two and three forging cycles, each cycle comprising one upsetting and one drawing out operation. High-speed steels belong to difficult-to-form materials with a narrow forging temperature interval. Forging above the maximum forging temperature may lead to grain coarsening. Below the minimum forging temperature, deformation resistance of the material increases, and the workpiece may fail. Using numerical modelling, special forging dies were designed and effective strain distribution was calculated for an axial cross-section plane in specimens after two and three forging cycles. The purpose of the analysis was to identify the relationship between the amount of effective strain and the shape and size of austenite grain after forging. The size of prior austenite grains was measured using the linear intercept method which is based on the Snyder-Graff method. Grain shapes were characterized in terms of circularity, which is the difference between the shape in question and a circle. With increasing amount of strain, the grains in the material became finer, as undissolved carbides impeded grain growth. In as-received rolled condition, the austenite grain size was G9. After three forging cycles, it was smaller, G11 (the higher the number, the smaller the grains). Circularity characterizes the complexity of a grain shape. After deformation, strongly non-circular grains were found in the material, although a certain portion of grains retained their round shapes. This was reflected in greater variance of circularity after the forging cycles.

Key words:

High-speed steel, forging, austenite grain size, circularity