The influence of hot forging on the size and frequency of carbides in HS 6-5-2

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Abstract:

This paper follows on from a paper entitled "Effects of hot forging on the shape and size of prior austenite grain in HS 6-5-2 high-speed steel" which was devoted to a microstructure analysis of slugs from rolled bars of a high-speed steel after two and three forging cycles, each cycle comprising one upsetting and one drawing out operation, and explored the shape and size of prior austenite grains. This paper therefore explores the volume fraction and density of carbides of different sizes in relation to locations within a forged workpiece. The first location was the centre of a specimen with the largest strain $\varepsilon ef = 8.1$ (after two forging cycles) and $\varepsilon ef = 9.9$ (after three forging cycles). Another location was at the periphery of the specimen, with a strain of $\varepsilon ef = 1.6$ after two forging cycles and $\varepsilon ef = 3.2$ after three cycles. Micrographs of carbide particles were taken using a scanning electron microscope and examined with NIS Elements image analysis software. The majority of carbides were sized between 0.2 and 2 μm. Larger particles were rare. The carbides which are less than 1 μm in size do not shrink in response to increasing strain and their quantity does not change appreciably. Carbides with a size of 1-2 μm show a different behaviour. In the central region of specimens, where strain is the largest, their amounts are much larger than in less-worked regions. The percentage of carbides in the matrix is larger in the heavily-worked region. The 1-2 μm carbides are probably products of carbide dissolution during forging and subsequent reprecipitation from austenite. Earlier investigations (reported in the above-mentioned paper) revealed that with increasing strain austenite grains become finer and less circular, and therefore the aggregate grain boundary area expands. Precipitation of carbides, which reduces the surface energy of grain boundaries, is thus favourable in terms of energy.

Key words:

HS 6-5-2, forging, size of carbides, effective strain