

Effects of deformation on the behaviour of chromium carbides in tool steel studied by use of semi-solid forming

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Abstract:

Induction hardening technology is mainly used for processing parts where high hardness, although conventional treatment of tool steels is ordinarily used in industrial practice, engineers continue to seek new procedures to rid tool steels of objectionable primary sharp-edged chromium carbides, which impair toughness. Fortunately, research into metal forming yielded new methods of modifying the microstructure of hypereutectoid steels. Using these methods, mechanical properties can be improved by virtue of eliminating objectionable sharp-edged carbides. These carbides resist dissolution and their size and shape make them undesirable microstructural constituents. Although they do improve wear resistance of the matrix, they also impair toughness and may act as stress concentrators. The microstructures produced by a sequence involving semi-solid processing and subsequent forming operations were different from conventional semi-solid-processed microstructures. In the former microstructures, the prior carbide network was broken up, dispersed, and became a strengthening constituent. Brittleness which plagues materials with prominent carbide networks was thus removed.

The experimental material used in this study was X210Cr12 tool steel. Two semi-solid processing temperatures were used: 1240°C and 1260°C. There were two holding times: 30 minutes and 60 minutes. Another variable was the number of reductions. The resulting microstructures were examined with respect to individual sequences and reductions applied. Detailed microstructure analysis was carried out using a scanning electron microscope (SEM). Chemical compositions of carbides were determined by means of EDS (Energy Dispersive X-ray Spectroscopy). Microhardness was measured in order to gather comprehensive materials data. The purpose of the study was to identify trends, if any, in microstructural property evolution in response to the above-described processing sequence.

Key words:

Semi-solid processing, primary chromium carbides, tool steel, carbide refinement