Heat Treatment Effects on the Mechanical Properties and Microstructure of CPM-M4 Tool Steel

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Abstract

Variations in heat treatments have significant effects on the microstructure of tool steels. For CPM-M4 tool steel, the changes in microstructure and mechanical properties were observed based off of variations in temperature. Five heat treatments with constant exposure time and variable austenitizing and tempering temperatures were performed on samples of the M4. During heat treatment, tool steels undergo microstructural transformations where carbides made up of primary alloying elements are created and grown while the surrounding matrix of material undergoes phase transformations. Using SEM, EBSD, and ImageJ analysis software, the phase fractions of the final microstructure for each treatment was quantified and compared. Changes in mechanical properties were assessed by macro-hardness and nanoindentation. Based on the data, a maximum hardness was achieved for samples with an austenitization temperature of 2200°C and a tempering temperature of 925°C. This highest hardness did not correspond to the highest fraction of the hardened carbide and martensite phases. This is due to interactions between both the phases present in the matrix as well as the size and distribution of the carbides.

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