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Retained austenite in tool steels - how heat treatment of tool steels effects retained austenite and tool performance

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Retained austenite is widely regarded as a detrimental microstructural constituent in high-alloyed tool steels. However, an undesired amount of it often remains in the microstructure due to the incomplete transformation of austenite into martensite during the hardening process of tool and high-speed steels. Resulting effects are dimensional instabilities and internal stresses after the heat treatment, which leads to limited tool performance. This paper addresses the preconditions of retained austenite formation and its microstructural and sub-microstructural appearance. Even though the retained austenite content can be difficult to detect, there are reliable methods for determining its volume in high-alloyed tool steels such as X-ray diffraction, electron backscatter diffraction and transmission electron microscopy. Specified heat treatment such as sub-zero treatments or multi tempering steps of tools can help to avoid excessive retained austenite content and therefore extend tool life significantly. Evidence of the negative effects of un-transformed austenite and different solutions to avoid this phenomenon are given and discussed in this paper by means of real tooling cases in various fields of application. The first case shows the undesired effects on the dimensional stability of a die plate made of 1.2379 (X153CrMoV12). A further case presents a cold forming punch made the of high speed steel HS 4-3-1.5 which failed after a short period of time and showed fatal fractures originating from an sub-optimal microstructure due to an insufficient after heat treatment.
Keywords: Retained austenite, tool steels, high-speed steels, metallography, heat treatment, die plates, cold forming

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