

## Simultaneous Improvement of Wear Performance and Toughness of Ledeburitic Tool Steels by Sub-Zero Treatment

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**Abstract :** The strength, hardness, and toughness (ductility) are in strong conflict for the metallic materials. The only possibility how to make their simultaneous improvement is to provide the microstructural refinement, by cold deformation, and subsequent recrystallization. However, application of this kind of treatment is impossible for high-carbon high-alloyed ledeburitic tool steels. Alternatively, it has been demonstrated over the last few years that sub-zero treatment induces some microstructural changes in these materials, which might favourably influence their complex of mechanical properties. Commercially available PM ledeburitic steel Vanadis 6 has been used for the current investigations. The paper demonstrates that sub-zero treatment induces clear refinement of the martensite, reduces the amount of retained austenite, enhances the population density of fine carbides, and makes alterations in microstructural development that take place during tempering. As a consequence, the steel manifests improved wear resistance at higher toughness and fracture toughness. Based on the obtained results, the key question "can the wear performance be improved by sub-zero treatment simultaneously with toughness" can be answered by "definitely yes".

**Keywords :** ledeburitic tool steels, microstructure, sub-zero treatment, mechanical properties

**Conference Title :** ICMME 2018 : International Conference on Metal Materials and Engineering

**Conference Location :** Copenhagen, Denmark

**Conference Dates :** June 11-12, 2018