Phase composition and stress state in the surface layers of burnished and gas nitrided Sverker 21 and Vanadis 6 tool steels

Daniel Toboła, Bogusz Kania

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Title: Phase composition and stress state in the surface layers of burnished and gas nitrided Sverker 21 and Vanadis 6 tool steels

Daniel Toboła[a], Bogusz Kania[b]

[a] *Institute of Advanced Manufacturing Technology (IAMT), Wrocławska 37a, 30-011 Cracow, Poland*
[b] *Institute of Metallurgy and Materials Science of Polish Academy of Sciences, 25, Reymonta St., 30-059 Cracow, Poland*

ABSTRACT

The effects of plastic deformation, by slide diamond burnishing as a pre-nitriding treatment, of the surface layers of a conventional, Sverker 21, and a powder metallurgy, Vanadis 6, tool steel were examined by metallography and X-ray diffraction for phase and internal stress analyses. Two sequential processes: turning-nitriding and turning-burnishing-nitriding were compared in the affected nitrided regions: surface (compound layer) and sub-surface (diffusion zone). Compared to nitriding only, prior burnishing leads to an increase in the thickness of the affected region, containing Fe_3N, Fe_4N, CrN nitrides, by 60% from 30-38 µm for Sverker 21 and by more than 300% from 2-3.5 µm for Vanadis 6 steels. A homogenization of the stress state to isotropic compression was found in the surface layers of both prior burnished tool steels.

Keywords:
tool steel, phase analysis, residual stresses, slide diamond burnishing, gas nitriding

Introduction

Large influence on the wear resistance of tool steels is attributed to carbides formed after heat treatment and distributed as evenly as possible in the matrix [1]. Microhardness of different types of carbides is very high [2,3], from, in HV 0.02, 2500-3000 for (V rich) MC type, through 1200-1900 for (Cr rich) M_7C_3 carbides down to 700-800 of cementite, see Figure 1. Various surface treatments are used to increase wear resistance, including nitriding [4,5] and burnishing [6,7].

During nitriding a compound layer and a diffusion zone are formed. The compound layer consists primarily of iron-based nitrides or carbonitrides, while in the diffusion zone nitrogen forms nitrides with alloying elements with a higher affinity to nitrogen [8-10]. In alloy and tool steels the very fine hard (and often complex) ensembles contain atoms of several metals, including iron and alloying elements such as Cr, V, Mo, W. Other elements with high affinity for nitrogen, such as Ti, Zr, also form nitrides with high hardness, but they are much larger compared to the nitrides of Cr, V, Mo and W. The precipitation hardened