



Institute of Aviation Technologies and Materials (IATM)
Departments of Mechanical Design Technology

THE EFFECT OF GRAIN SIZE OF STEEL R6M5 ON THE DIFFUSION RATE AND GROWTH KINETICS OF THE HARDENED LAYER AFTER ION NITRIDING IN A GLOW DISCHARGE*

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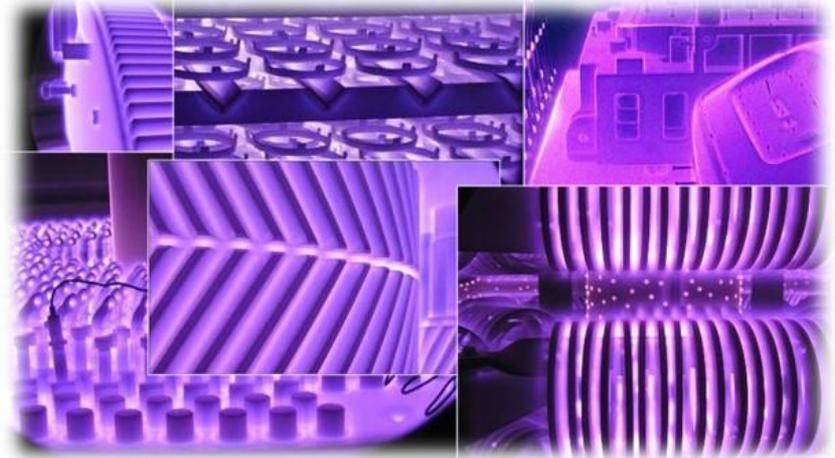
Relevance

EFRE 2020

УГАТУ

Due to the continuous improvement of science, engineering and technology, high demands are placed on the materials used for mechanical and operational properties. These requirements contribute to the use of not only expensive materials with the necessary range of properties, but also the structural modification of already used materials by thermal or mechanical treatments.

The purpose of this work was to study the effect of grain size and morphology of high-speed tool steel R6M5 on the microstructure and microhardness after ion nitriding in a glow-discharge.



Methods of study

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For carrying out an experiment were used samples from tool steel R6M5 which has been subjected to severe plastic deformation torsion (SPDT) to create a highly fragmented and disoriented ultrafine-grained structure.

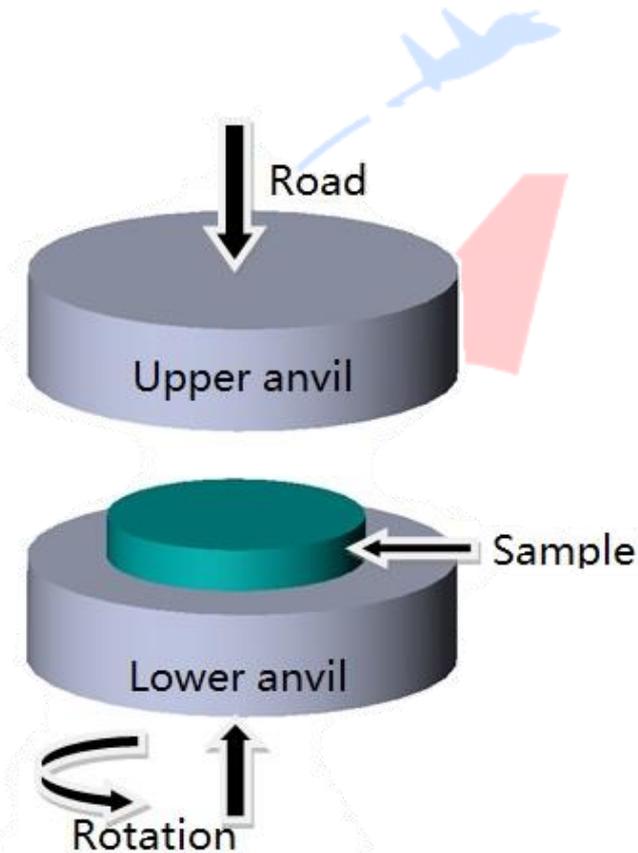


Figure 1. A schematic illustration of the processes of severe plastic deformation torsion

Table 1. Chemical composition R6M5 (wt %)

C	Si	Mn	Ni	Cr	Mo	W	V	Co	Fe	S	P
0,82...0,9	max 0,5	max 0,5	max 0,4	3,8...4,4	4,8...5,3	5,5...6,5	1,7...2,1	max 0,5	~80	max 0,025	max 0,03

Methods of study

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The experiment were performed on a modernized electron-beam installation ELU-5M. The ion nitriding were carried out in a gas mixture from argon, nitrogen and hydrogen (50% Ar + 35% N₂ + 15% H₂) at a gas pressure $p=200$ Pa and a temperature $T=450$ °C.

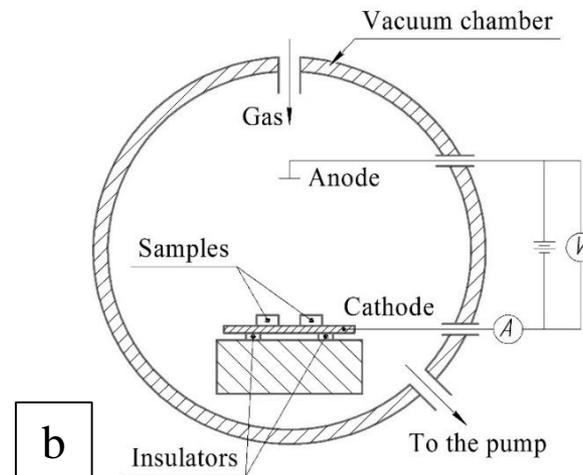
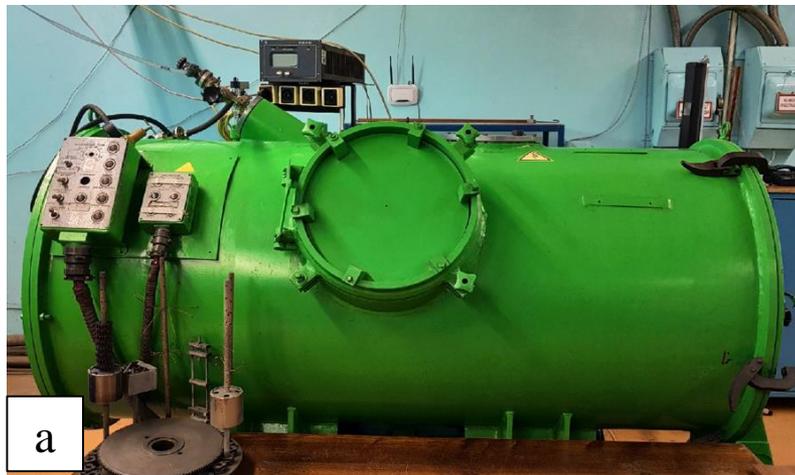


Figure 1. Modernized electron-beam installation ELU-5M:
a-general view of the installation, b-installation diagram

Methods of study

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Investigation of the microhardness of the surface layer of nitrated samples was carried out on oblique sections (angle 7°) using a Struers Duramin-2 hardness gage. Optical photos of prints were obtained by means of optical microscope Olympus GX51.



Figure 1. Struers Duramin-2
hardness gage



Figure 2. Optical microscope
Olympus GX51

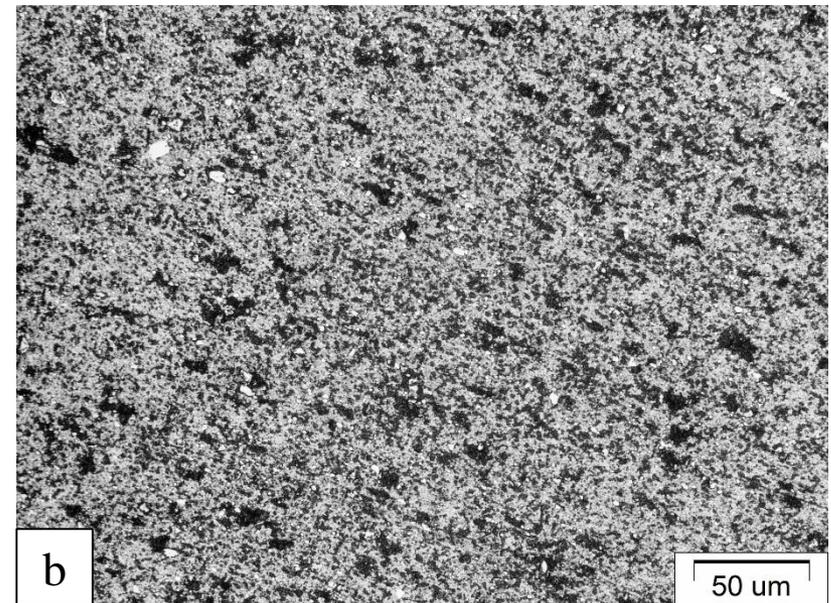
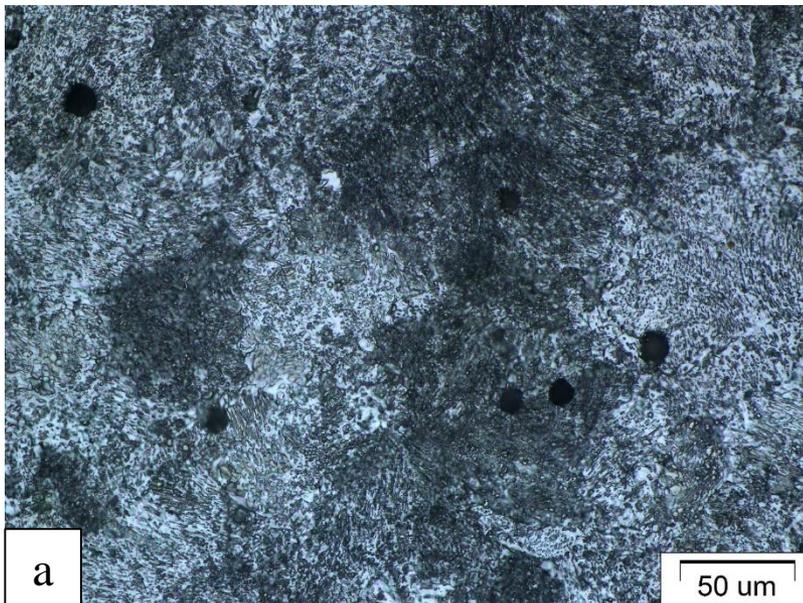


Figure 1. Optical photographs of the structure:
a-original R6M5, b-R6M5 after SPDT

Results

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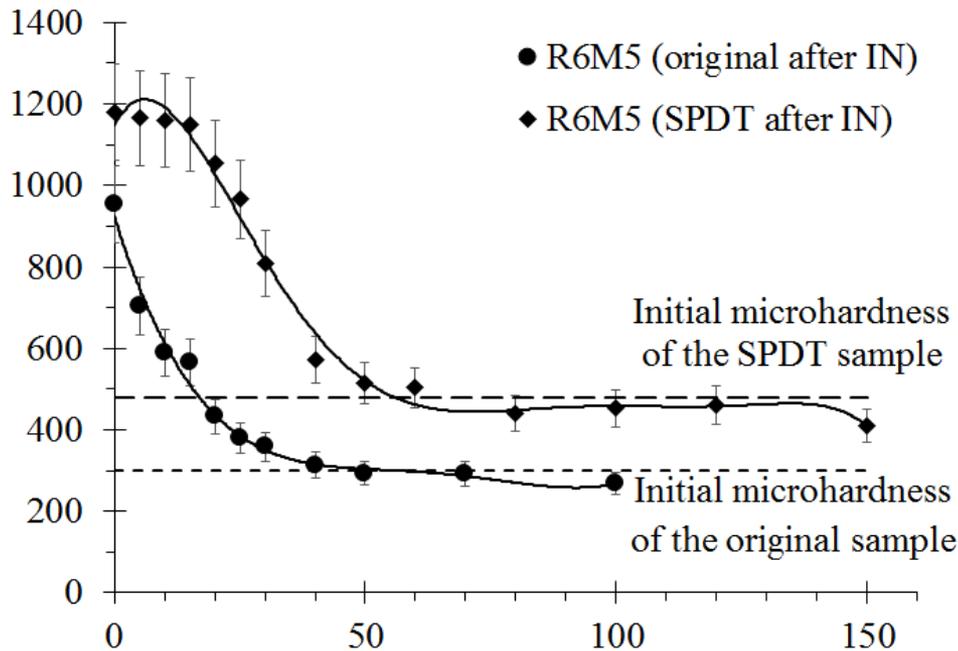


Figure 1. Distribution of microhardness by depth of samples from R6M5 after ion nitriding at 450 °C during 2 hours

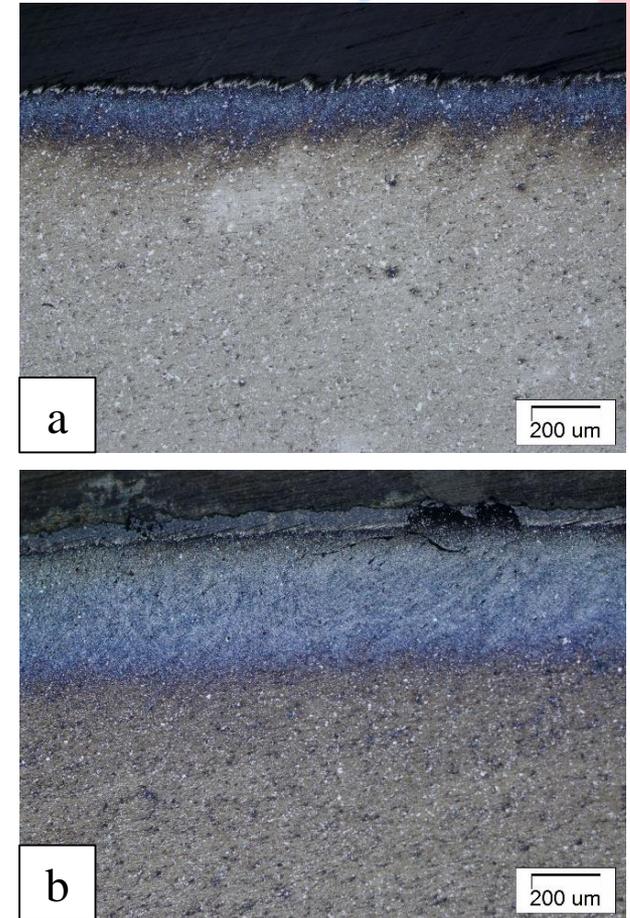


Figure 2. Optical photographs of the structure of samples after ion nitriding at 450 °C during 2 hours: a-original R6M5, b-R6M5 after SPDT

Conclusions

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- The use of severe plastic deformation torsion before ion nitriding in a glow-discharge increases the diffusion of the saturation element deep into the processed material due to the formation of a highly fragmented and disoriented ultrafine grain structure.
- The use of SPDT before ion nitriding in a glow-discharge increases the thickness of the hardened layer and surface hardness by 2 times.