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ABSTRACTS BOOK

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Hardening of Steel Perforated Tape by Nd:YAG Laser

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INTRODUCTION

Perforated metal materials (PMM) have wide application in the manufacture of products from small and medium-carbon steels. One of the new areas of PMM application can be their use as cutting elements in the manufacture of machining tools [1]. In this case it is necessary to carry out strengthening of cutting surfaces to increase their hardness.

One method may be laser processing, which in contrast to the known processes of heat strengthening (bulk quenching of high-frequency currents, electric heating and etc) is not bulk but the local, superficial process, without change of surface both macro and microgeometry [2]. In the present work the effect of laser exposure modes on the microstructure and hardness of steel perforated tape has been investigated.

EXPERIMENTAL METHODS

The St50 steel samples from perforated tape 1.2 mm thick (Fig.1.) were irradiated by pulsed Nd:YAG laser with following parameters: $\lambda=1064nm$, $\tau=6$ ns, $I=104.2MW/cm^2$. Different scan speeds (doses) were used in the experiments. Hardness by methods of micro- and nanoindentation and microstructure of the surface layers were investigated.

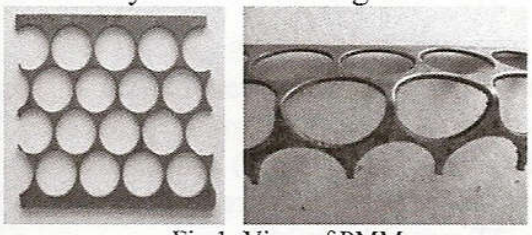

Fig.1. View of PMM

RESULTS AND DISCUSSION

Investigations showed that after the laser treatment the microhardness increase from 1.68 to 2.50 GPa is observed in the surface layer of 1μm. Moreover, according nanoindentation in the layer of 0.1μm hardness increases to 5 GPa, with a small decrease in Young's modulus from190 GPa to 210 GPa.

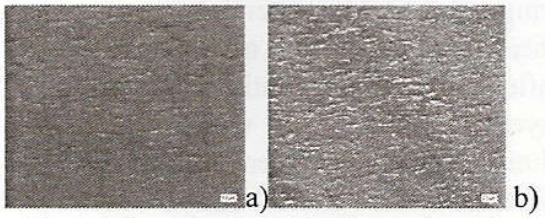

Fig.2. Micrographs of St50 samples (a) non-irradiated and (b) irradiated by Nd:YAG laser

Microstructure studies have shown refinement of the ferrite and pearlite structures in steel and the presence of a thin oxide films on the surface. Last is consistent with the results of nanoindentation. It should be noted that hardening of the laser beam was performed without melting of the surface that excludes both the macro roughness change and the need for subsequent machining.

CONCLUSION

The work shows that laser treatment leads to the hardness increase by 66% in surface layer of 0.1 μm and by 48% in layer of 1μm. The effect falls off at a depth of 2 μm. Changes in the microstructure with conservation of surface macrorelief are detected. The mechanisms of laser action processes and ways of possible applications of the new material are discussed.

REFERENCES

[1] Mironovs V., Lisicins M. Perforated materials and it using. RTU, Riga,(2015), 170 p.(in Latvian).

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