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Cavitation behaviour of the SUPERSTON alloy after laser treatment

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ABSTRACT

Purpose: Results of laser treatment at cryogenic conditions and its influence on microstructure, microhardness and cavitation resistance of the SUPERSTON alloy are presented in this paper.

Design/methodology/approach: New method of the laser remelting specimens diped in liquid nitrogen made by the CO_2 laser with 4000 W laser beam power and scanning velocity 0.5 and 1.0 m/min was employed. Observation microstructure was carried out by scanning electron microscope. Hardness of cross-section of the surface layer has been measured by the Vickers microhardness under load 0.49 N. Cavitation test in the water using rotating disc facility was done.

Findings: Laser remelting let obtain fine microstructure in surface layer and increase of microhardness and cavitation resistance, compared to casting the SUPERSTON alloy.

Research limitations/implications: The future investigations connected with environment conditions should be extend of internal stresses in the SUPERSTON alloy after laser remelting at cryogenic conditions.

Practical implications: Obtained results point at possibility of the increase hardness and cavitation resistance of the parts worked in cavitation conditions.

Originality/value: The propose laser treatment at cryogenic conditions could be used for surface consolidation of the copper alloys applied for ship propellers.

Keywords: Surface treatment; Laser remelting; Copper alloys; Cavitation

1. Introduction

The purpose of this article is to show the method of the laser remelting at cryogenic conditions of the SUPERSTON alloy and its influence on microstructure, hardness and cavitation resistance [1-8].

The SUPERSTON alloy is used for marine propellers which can undergo cavitation during exploitation. The laser remalting in liquid nitrogen is one of the method of reducing cavitation wearing of the copper alloys used for the ship propellers [9-15].

2. Methodology and materials for research

Chemical composition of the SUPERSTON alloy used for marine propellers, as the investigated material is shown in Table 1. Laser remelting was done by the TRUMPF laser TLF 6000 turbo. The laser beam dimension 1x20 mm, power 4000 W, scanning velocity: 0.5 and 1.0 m/min were used in this process. The laser treatment of the SUPESTON alloy was made after immersion specimens in liquid nitrogen (temperature -195^{0}C).

Table 1.
Chemical composition of the SUPERSTON alloy (wt. %)

Cu	Al	Mn	Fe	Ni	Zn	Sn	Pb
76.6	7.1	10.4	3.8	2.0	0.1	0.05	0.01

After laser treatment the microstructure of the surface and cross-section the SUPERSTON alloy was observed by scanning electron microscope (SEM).

Cavitation test in the water (average temperature 20^{0}C) was performed at rotating disc facility (Fig. 7). During the cavitation process the kinetics of the mass loss was determined.

3. Test results

3.1. Microstructure of the SUPERSTON alloy

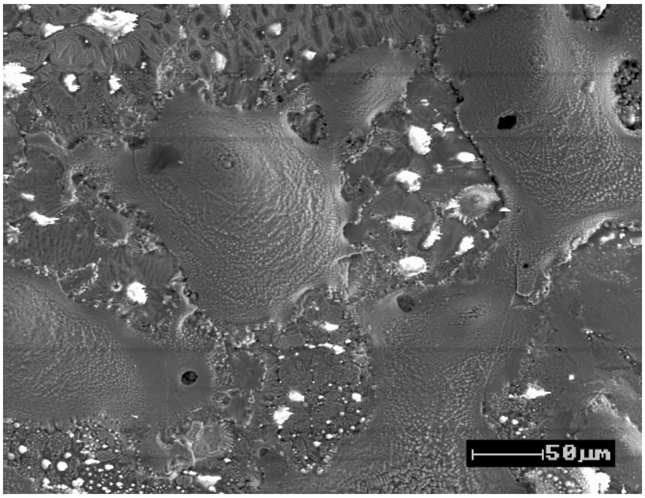

Fig. 1. Surface microstructure of laser remelted the SUPERSTON alloy (4000W, 0.5m/min)

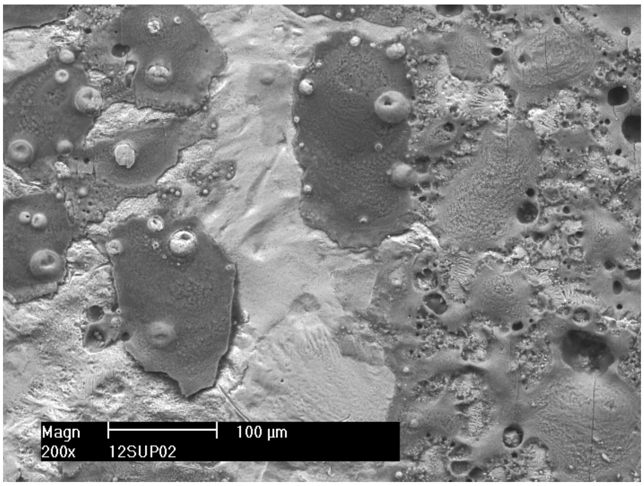

Fig. 2. Surface microstructure of laser remelted the SUPERSTON alloy (4000W, 1.0m/min)

Surface morphology of the SUPERSTON alloy remelted with 4000 W power, scanning velocity 0.5 and 1.0 m/min is presented in Figs 1 and 2.

Microstructure of casted and remelted the SUPERSTON alloy is shown in Figs 3 and 4. Microstructure of the SUPERSTON alloy as coasting consist of α phase, eutectoid mixture and manganese-iron phase (Fig. 3). After laser remalting fine microstructure without cracks in the surface layer is observed. (Fig. 4).

Average thickness of the remelted layer is about 300µm and demonstrate a structural connection with base material (Fig. 4).

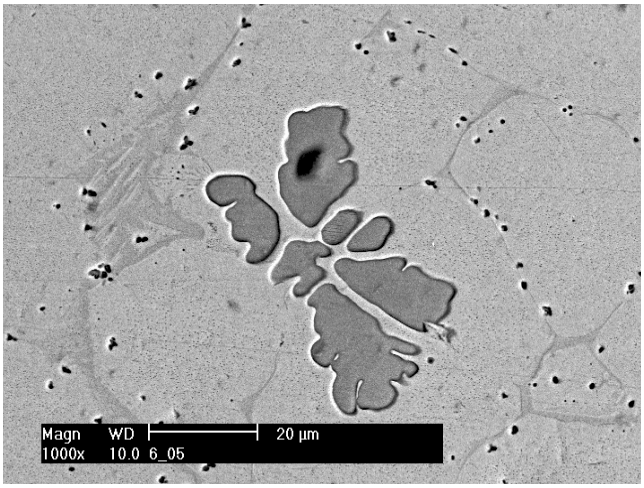

Fig. 3. Microstucture of the casted the SUPERSTON alloy

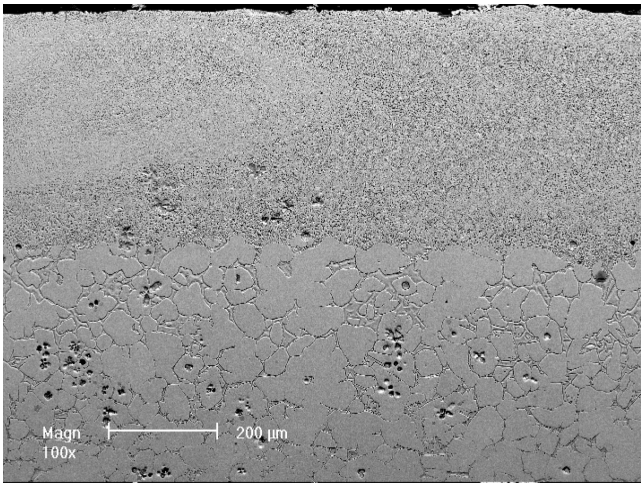

Fig. 4. Cross section microstructure of remelted the SUPERSTON alloy

3.2. Microhardness of the SUPERSTON alloy

Microhardness in the remelted layer of the SUPERSTON alloy made by the Vickers method under load 0.49 N.

Results of the microhardness measurements are presented in Figs 5 and 6.

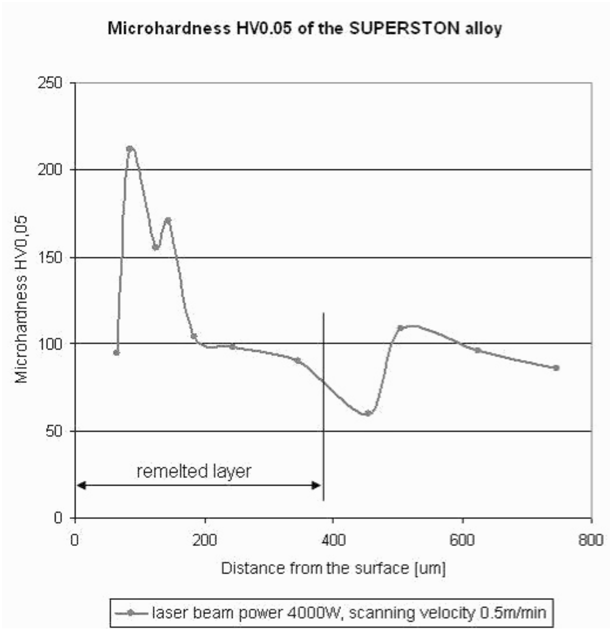

Fig. 5. Microhardness in cross-section of laser remelted layer of the SUPERSTON alloy (4000W, 0.5m/min)

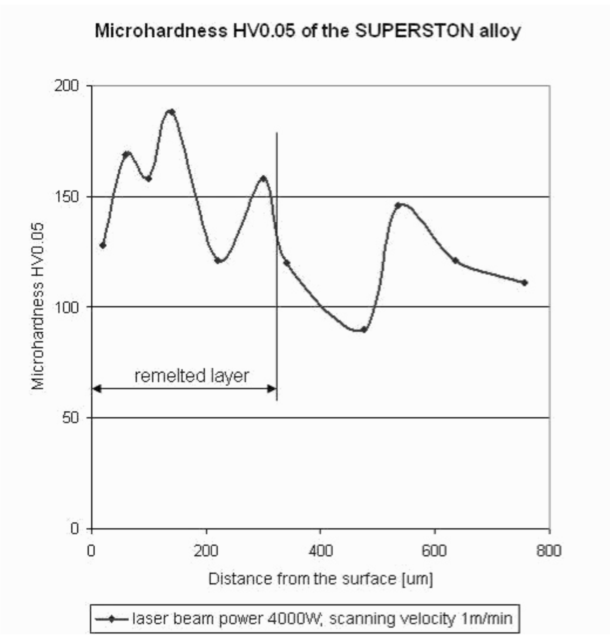

Fig. 6. Microhardness in cross-section of laser remelted layer of the SUPERSTON alloy (4000W, 1.0 m/min)

3.3. Cavitation test

The cavitation resistance test of the SUPERSTON alloy after laser remelting at cryogenic conditions was performed at the rotating disc facility Fig. 7.

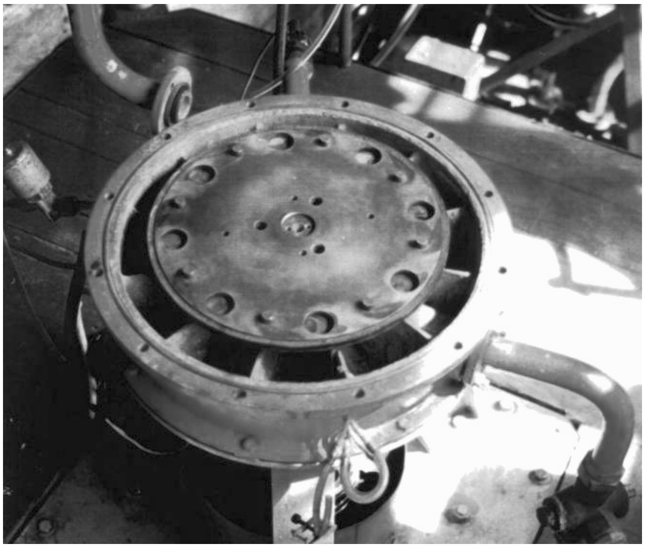

Fig. 7. The rotating disc facility for measurements of cavitation resistance

Average mass loss of the specimens after 5.25h of the cavitation test is presented in Fig. 8.

View of the base material and laser remelted specimens made of the SUEPRESTON alloy after cavitaton test is shown in Fig. 9.

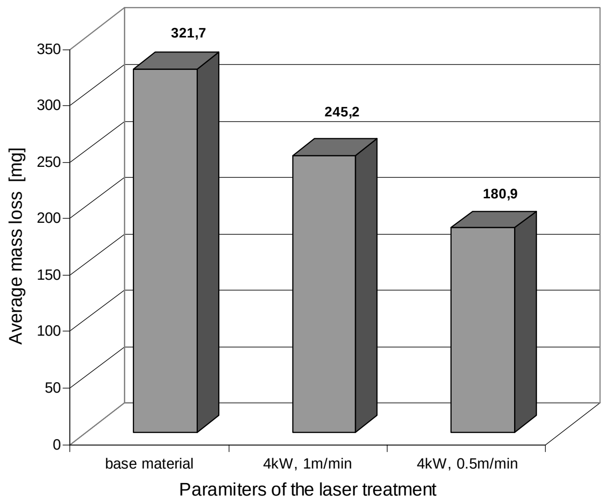

Fig. 8. Average mass loss of the SUPESTON alloy remelted in the different conditions

4. Conclusions

Microstructure of the SUPERSTON alloy after laser remelting at cryogenic conditions is fine-crystalline without cracks and manganese-iron phase.

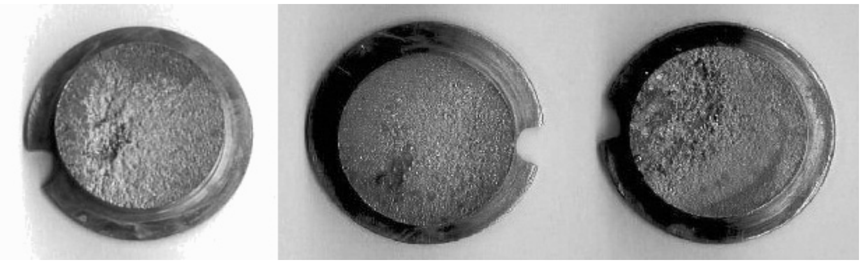

Fig. 9. Surface of the SUPERSTON alloy after cavitation test by 5.25h: a) 4000W, 0.5m/min; b) 4000W, 1.0m/min; c) base material - as casting

Laser remelting caused the increase hardness of the SUPERSTON alloy to 200 HV 0.05.

Most beneficial increase of cavitation resistance (about 30%) obtained for laser remelting the SUPERSTON alloy with 4000 W power and 0.5 m/min scanning velocity.

Acknowledgements

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