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B. Majkowska[1], W. Serbiński[1], I. Skalski[2]
[1]Gdansk University of Technology, Faculty of Mechanical Engineering, Department of Materials Science and Engineering, Gdansk, Poland
[2]Ship Design and Research Centre, Gdansk, Poland

ASSESSMENT OF CAVITATION EROSION DAMAGE OF LASER REMELTED THE SUPERSTON ALLOY

ABSTRACT

Influence of laser treatment at cryogenic conditions on surface microstructure after cavitation test of the SUPERSTON alloy are presented in this paper. The cavitation test was performed using the rotating disc facility in IPM PAN Gdansk. The kinetics of mass loss during the cavitation process was determined for casting and laser remelted specimens. Surface and cross-section microstructure of the SUPERSTON alloy after laser treatment and cavitation test was observed by optical and scanning electron microscope.

Key words: *SUPERSTON alloys, laser treatment, cavitation, microstructure*

INTRODUCTION

Degradation by the cavitation is very popular in ship propellers, usually made of copper alloys e.g. SUPERSTON alloy [1-3]. The cavitation phenomenon causes excessive vibrations, noise and finally degredation of the propeller blades (Fig. 1).

Fig. 1. Cavitation erosion damage of the ship propeller [4]

This phenomenon is the result of formation of vapour bubbles in the fluid in regions where the flow conditions produce fall of pressure and subsequent violent collapse of these bubbles on surface of these blades in neighbouring areas where the local pressure is higher.

Ship propellers require periodic surface reconditioning, polishing, particularly if either cavitation, corrosion or mechanical damage have been significant. This must be carefully carried out by skilled personnel to avoid further damage [5].

One of the method of the surface protection of the propeller's blades against cavitation attack can be the laser surface remelting [6, 7].

EXPERIMENTAL

In this work the research the SUPERSTON alloy was used. Its chemical composition is shown in Table 1.

Table 1. *Chemical composition of the SUPERSTON alloy % wt*

Cu	Al.	Mn	Fe	Ni	Sn	Zn	Pb
76.6	7.1	10.4	3.8	2.0	0.05	0.10	0.01

Microstructure of the casting SUPRESTON alloy contains α phase, eutectoid mixture ($\alpha + \gamma_2$), manganese-iron phase shown in Fig. 2.

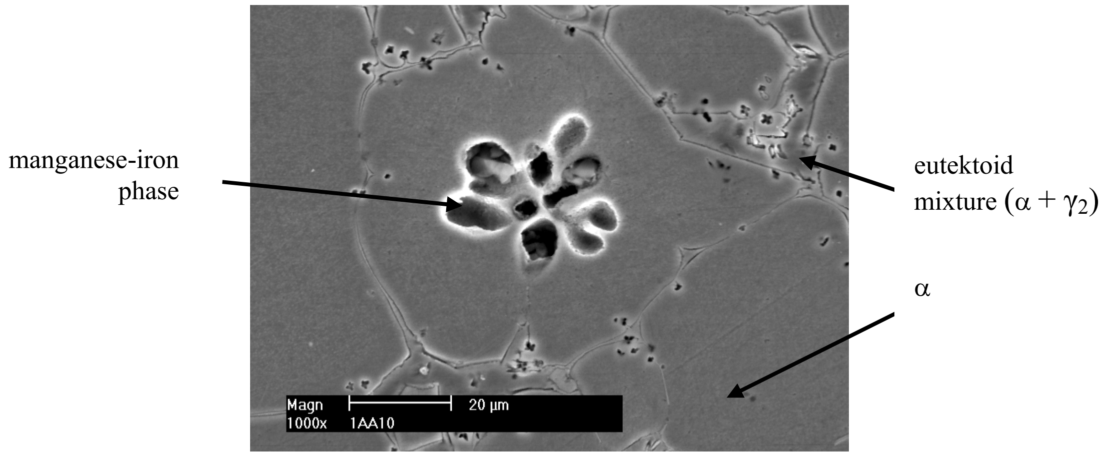


Fig. 2. Microstructure of the SUPERSTON alloy (as casting)

Laser remelting was done by the TRUMPF laser TLF 6000 turbo in Kielce University of Technology. During of the laser remelting process the specimens were immersed in liquid nitrogen. The laser beam dimension 1x20 mm, power 4000, 5000 and 6000 W, scanning velocity 0.5 and 1.0 m/min were used in this process.

Cavitation test in the water (average temperature 20°C) was performed using rotating disc facility [8, 9]. During the cavitation test, mass loss of the SUPERSTON alloy was determined. Every line on the graph presents average of the three mensurations during cavitation test. Results of this test are shown in Fig. 3.

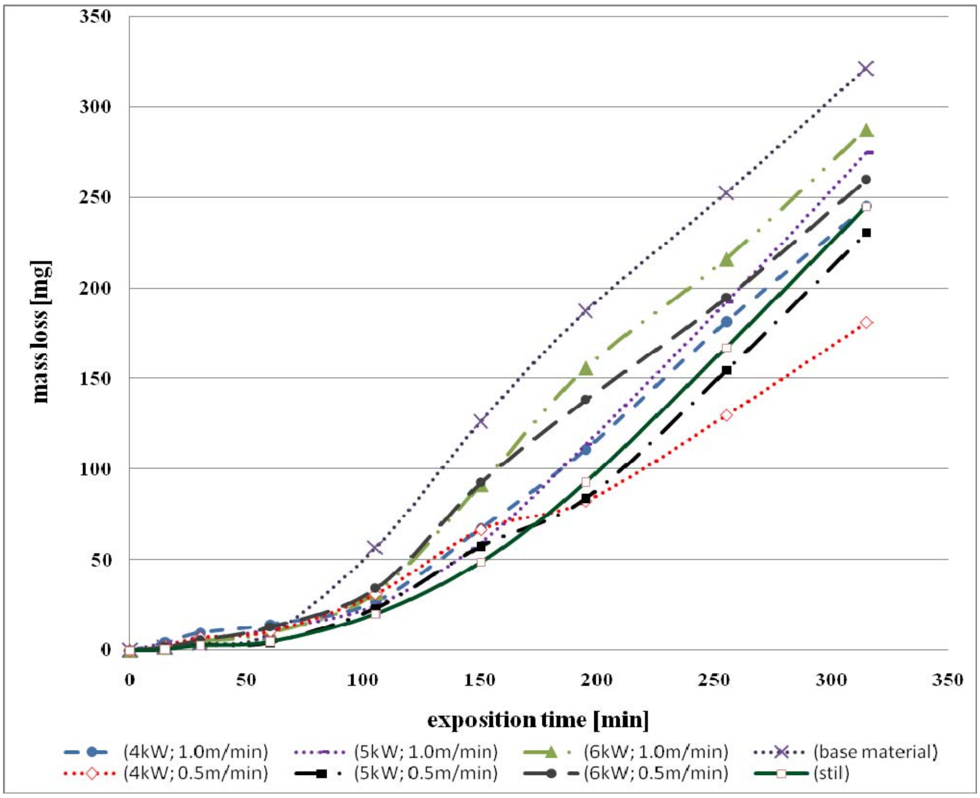


Fig. 3. Mass loss of the SUPERSTON alloy depend on the time of exposition

Influence of the laser remelting parameters (P, v) on mass loss (dm) of the SUPERSTON alloy is presented in Fig. 4.

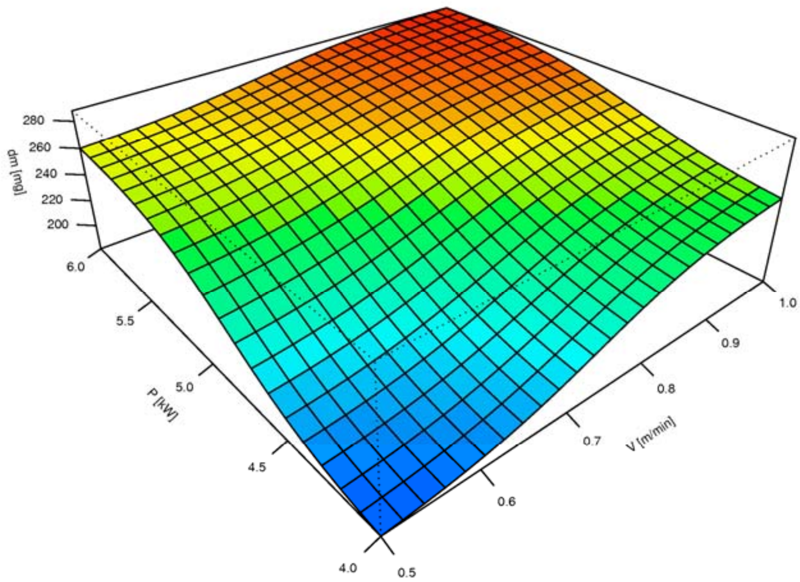
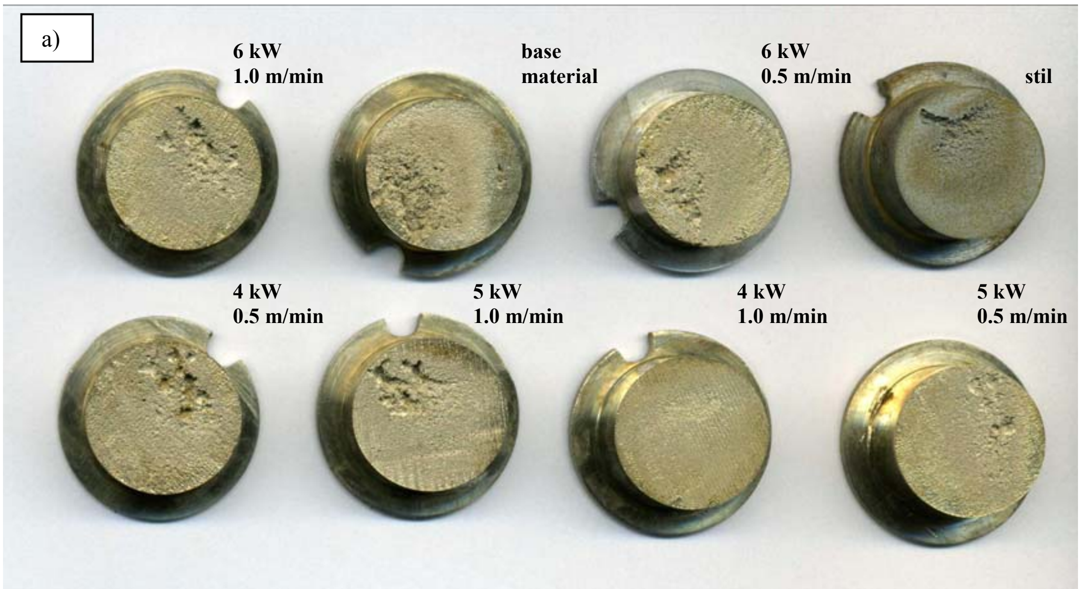


Fig. 4. Mass loss as a function of remelting paramiters

Surface view of the specimens the SUPERSTON alloy after laser remelting and cavitation test for 150 min and 315 min are presented in Fig. 5.



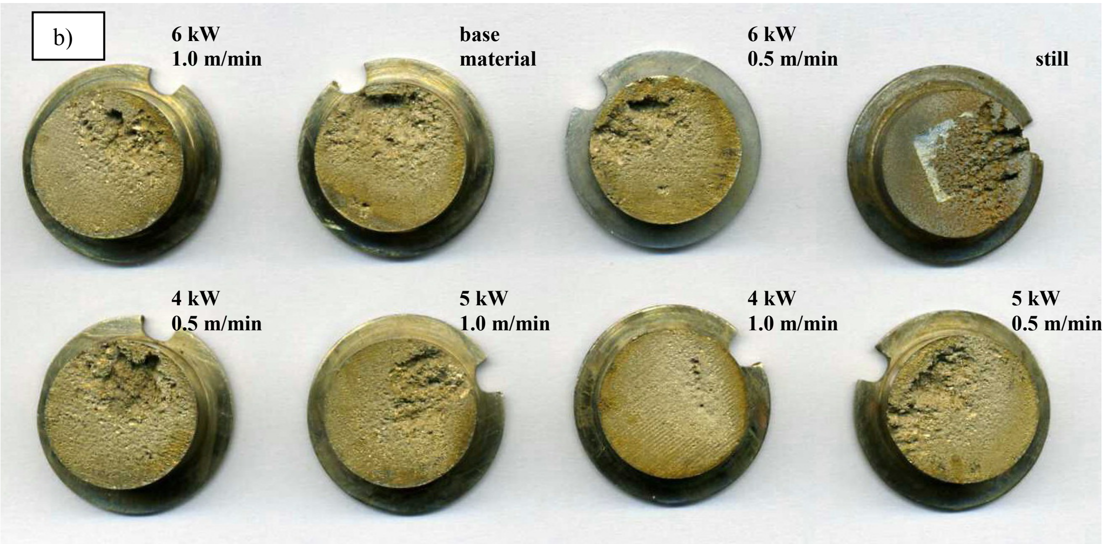


Fig. 5. Surface of the laser remelted specimens after the cavitation test for: a – 150 min; b – 315 min

Microstructure and cross section of the laser remelted the SUPERSTON alloy after cavitation test was observed by optical and scanning electron microscope. Increase of cavitation resistance was observed for the laser remelted specimens for paramiters 4000 W power and 0.5 m/min scanning velocity.

View of the surface and cross-section microstructure the laser remelted of the SUPERSTON alloy are shown in Figs. 6 and 7.

In Fig. 6 the brittle fracture and some cracks in the most intensity cavitated erosion region of the remelted layer the SUPERSTON alloy are observed.

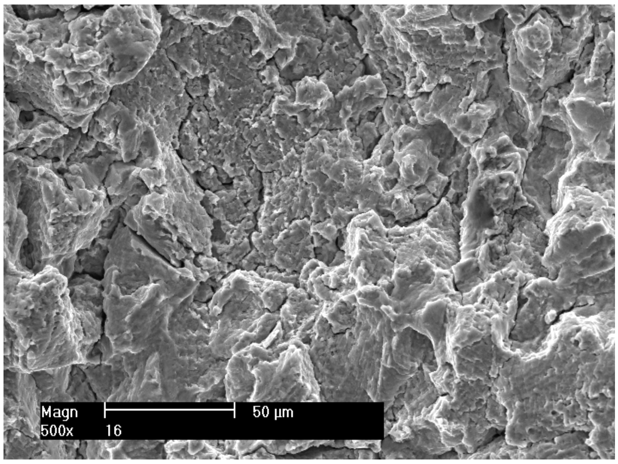


Fig. 6. Surface view of the most intensity cavitation region of the SUPERSTON alloy after laser treatment for 4000 W, 0.5 m/min

Microstructure of the cross-section laser remelted the SUPERSTON alloy at initial and finally stage the cavitation erosion test shown in Fig. 7.

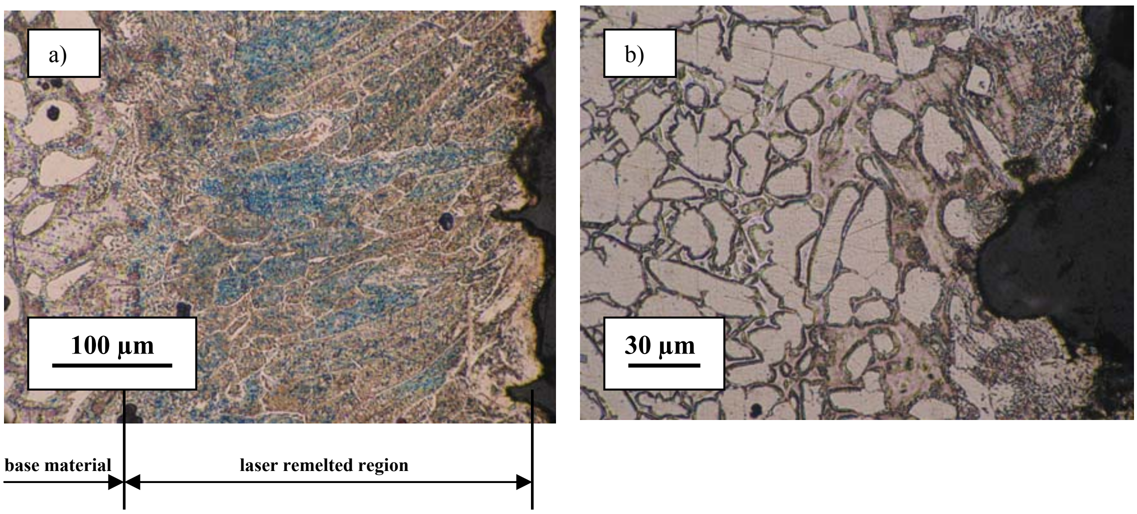


Fig. 7. Cross-section of the laser remelted layer (4000 W, 0.5 m/min) after the cavitation test for: a – 55 min, b – 315 min

CONCLUSION

1. Laser remelting at cryogenic conditions the SUPERSTON alloy caused the refinement of microstructure in obtained surface layer.
2. After laser remeltong at cryogenic conditions obtained increase of cavitation resistance of the SUPERSTON alloy, about 40% compare to base material.
3. The most increase of cavitation resistance was observed after laser remelting the SUPERSTON alloy for 4000 W power and 0.5 m/min scanning velocity.

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