THE MICROSTRUCTURE OF HETEROGENEOUS MATERIALS BASED ON NI AND B4C POWDERS USING A COLD SPRAY AND STRATIFIED SELECTIVE LASER MELTING TECHNOLOGIES

Filippov A.A.[1,a], *Fomin V.M.*[1,2,3], *Kosarev V.F.*[1], *Ryashin N.S.*[1], *Orishich A.M.*[1,3], *Malikov A.G.*[1], *Golyshev A.A.*[1]

[1] Khristianovich Institute of Theoretical and Applied Mechanics of the Siberian Branch of the Russian Academy of Sciences, Novosibirsk, Russia
[2] Novosibirsk State Technical University, Novosibirsk, Russia
[3] Novosibirsk State University, Novosibirsk, Russia
[a]filippov@itam.nsc.ru

The work is dedicated to the creation of new ceramic-composite materials based on boron carbide, nickel and using a laser treatment in order to obtain three dimensional objects henceforth. The perspective way of obtaining which has been suggested by the authors combined two methods: cold spray technology and subsequent laser post-treatment [1,2]. At this stage, the authors focused on the interaction of the laser with the substance, regardless of the multilayer object development. The investigated material of this work was the metal–ceramic mixture based on boron carbide, which has high physical and mechanical characteristics, such as hardness, elastic modulus, and chemical resistance. The titanium alloy VT-20 was used as substrate. The nickel powder as a binder and different types of boron carbide were used. The ceramic content varied from 0 to 90% by mass in initial mixture. The cold spray coating thickness was ranged from 250 to 50 μm. Cold spray coatings could characterized as heterogeneous cermet coatings (Fig. 1a) with low porosity and ceramic content at range 0 to 27% by mass . After laser melting (Fig 1b) is shown compaction of deformed nickel particles, reduction of pores in the volume, smoothing of the coating surface, disappearance of the boundaries between the coating particles.

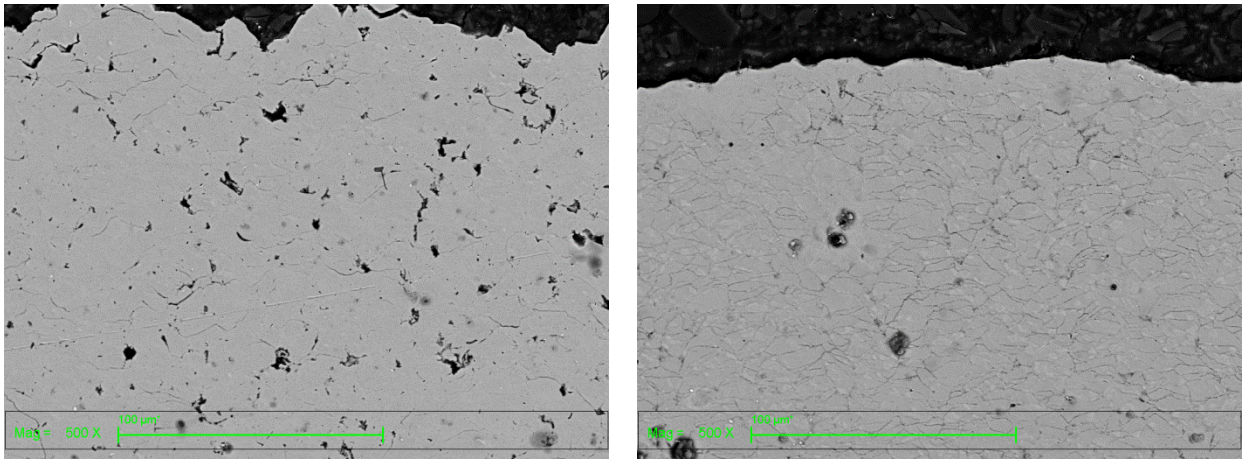

Figure 1. SEM-image cold spray coating pure nickel a) before and b) after laser treatment

Thin ceramic layers were obtained by the combined method and cross-sections microstructure of different seams were studied. It was shown that at low ceramic concentrations melted coating contains bubbles with ceramic particles. At ceramic concentrations 90% in initial mixture a continuous cold spray coating layer transforms to seams under laser radiation. There are some chemical reactions in the seam cavity (Fig.2 a,b). The authors made an assumption about the chemical transformation of boron carbide to whiskers of titanium carbide as at work [3]

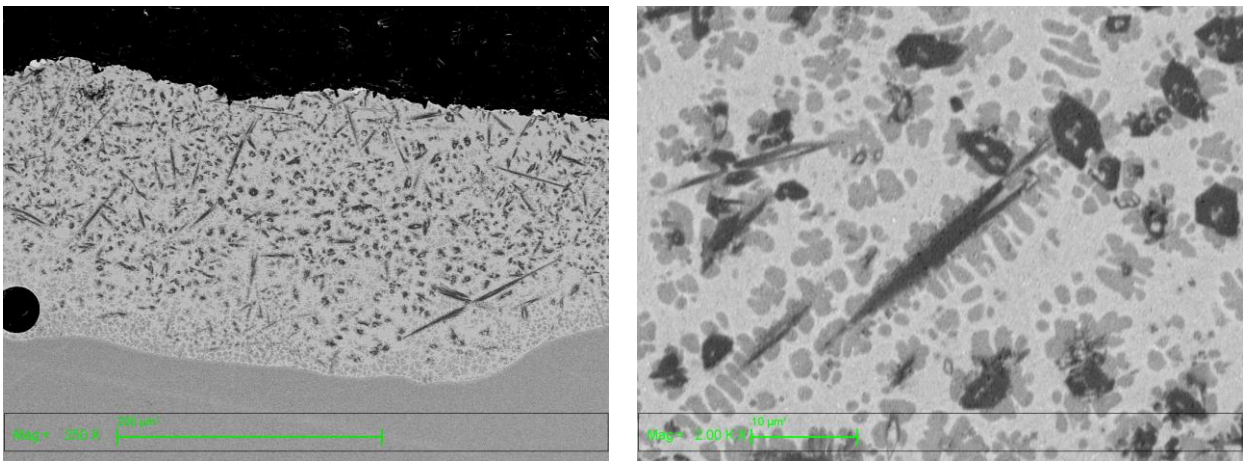

Figure 2. SEM-image the seam cavity cermet coating with different magnification:
a) 250X, b) 2000X

Acknowledgements. This work was supported by a grant of the Russian Scientific Foundation "The physical basis for the creation of heterogeneous materials using additive technologies" №16-19-10300.

References

1. Filippov, A.A., Fomin, V.M., Malikov, A.G., Orishich, A.M. Effect of laser radiation on the structure of metal–ceramic mixtures based on boron carbide (2017) International Journal of Nanomechanics Science and Technology, 8 (1), pp. 55-66. doi: 10.1615/NanomechanicsSciTechnolIntJ.v8.i1.50.
2. Filippov A.A., Fomin V.M., Malikov A.G., Orishich A.M. Selective laser sintering of cermet mixtures Ti and B4C // 18th International Conference on the Methods of Aerophysical Research (ICMAR2016) (Russia, Perm, 27 Jun.-3 Jul., 2016) : AIP Conference Proceedings. –S.l.: 2016. –Vol. 1770. –P. 030095. doi: 10.1063/1.4964037.
3. Q. W. Meng, T. L. Geng, and B. Y. Zhang, "Laser Cladding of Ni-Base Composite Coatings onto Ti–6Al–4V Substrates with Pre-Placed B4C + NiCrBSi Powders," Surface Coatings Technol. **200**, 4923–4928 (2006).