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ВОССТАНОВЛЕНИЕ ВЫСОКОНАГРУЖЕННЫХ ПОДШИПНИКОВ СКОЛЬЖЕНИЯ ТЯЖЕЛЫХ РЕДУКТОРНЫХ ПЕРЕДАЧ СУДОВОГО ТРАНСПОРТА

RESTORATION OF HIGHLY LOADED PLAIN BEARINGS OF HEAVY GEAR TRANSMISSIONS OF MARINE TRANSPORT

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Аннотация. В настоящей работе предложена технология восстановления высоконагруженных подшипников скольжения тяжелых редукторных передач судового транспорта. Показано, что применение процесса дуговой наплавки рабочего покрытия из композиционного материала состава $Al_{12}Si_2CuMgNi$ + 10 % SiC с погонной энергией 3780 Дж/мм приводит к уменьшению среднего размера кристаллов β-фазы (SnSb) в 5,7 раза промежуточного слоя из баббита Б83, расположенного на подложке из стали 20.

Ключевые слова: подшипники скольжения, система сталь-баббит, композиционные материалы, дуговая наплавка, погонная энергия.

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Annotation. The technology for the restoration of highly loaded plain bearings of heavy gear transmissions of marine transport is proposed in this paper. It is shown that the use of the arc surfacing process of the working coating made of composite material of $Al_{12}Si_2CuMgNi$ + 10 % SiC composition with a energy of 3780 J/mm leads to a decrease in the average size of the β-phase crystals (SnSb) by 5.7 times in the intermediate layer of babbitt B83, located on a substrate of steel 20.

Keywords: plain bearings, babbitt-steel system, composite materials, arc surfacing, energy.

Highly loaded plain bearings, which are layered composites of the steel-babbitt system, are an integral structural element of heavy-duty gear transmissions in marine transport. The base material for forming the antifriction layer on the surface of the steel substrate is the B83 babbitt alloy [1, 2]. How-

ever, after the guaranteed service life of such friction units has expired, scheduled repair work is required to restore the worn antifriction layer. Despite the labor intensity and relative high cost, the most common technological method of repair is currently refilling B83 babbitt [3, 4]. On the other hand, the use of the arc surfacing process can become a very promising and prospective method of repairing such sliding bearings. Moreover, as a material for the deposited antifriction coating, particle reinforced composite materials (CM) based on aluminum, developed in recent years, are of particular interest, allowing for an expansion of the range of triboloading of friction units [5, 6]. Therefore, the formation of functionally organized layered compositions consisting of a steel base, an intermediate babbitt layer and a working coating made of CM is an urgent task. In this case, special attention should be paid to maintaining the favorable structure of the intermediate layer, which is what this work is devoted to.

The working coating of the composite material $Al_{12}Si_2CuMgNi$ + 10 % SiC was applied to the surface of the bimetallic sample by arc surfacing with a energy of 3780 J/mm. The bimetallic sample, manufactured using traditional casting technology, was a plate measuring 300 × 150 mm, consisting of a substrate (steel 20 according to GOST 1050) and an intermediate layer (babbitt B83 according to GOST 1320) with a thickness of 10 and 4 mm, respectively. The structure of the intermediate layer made of B83 alloy was studied by optical microscopy using a Leica DMILM microscope, and the size of the β-phase (SnSb) crystals was estimated using the KOMPAS-3D v18.1 automated design system.

After the formation of the working coating, the cross-sectional area of the β-phase crystals (SnSb) in the region of the intermediate layer adjacent to the deposited working coating does not exceed 2000 μm^2, while in the initial state this parameter reaches 5000 μm^2 (Fig. 1).

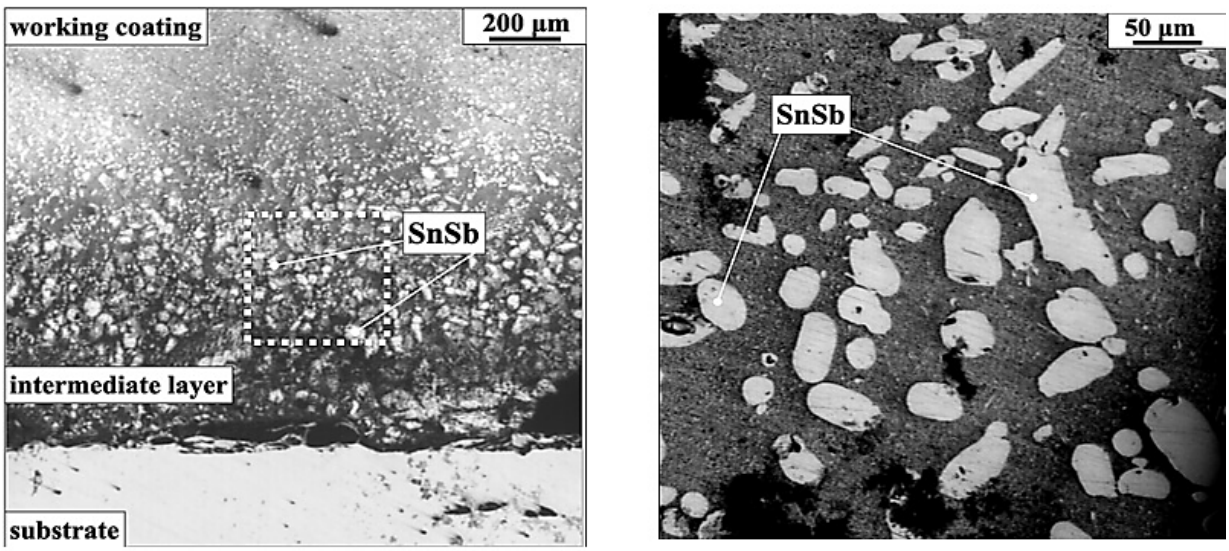

Figure 1 – Microstructure of the intermediate layer of B83 alloy
after arc surfacing of the working coating (a) and in the initial state (b).
The area for studying and analyzing the size of β-phase crystals is highlighted

As a result of recrystallization, the proportion of minimum-size β-phase crystals (cross-sectional area less than 500 μm^2) increased by 4 %, and large β-phase inclusions (area from 2000 to 5000 μm^2) were not detected in comparison with the initial state. The average size of β-phase crystals in the intermediate layer after arc surfacing of the working coating and in the initial state is 31.1 and 5.4 μm, respectively. It should be noted that the interface between the deposited working coating made of CM, as well as the intermediate layer and the steel substrate is continuous, in the absence of imperfections – pores, discontinuities, etc. (Fig. 1, a).

Thus, based on the results of the work carried out, a technology for the restoration of highly loaded plain bearings of heavy reduction gear transmissions of marine transport was proposed. It was established that due to the thermal effect of the arc surfacing process with a energy of 3780 J/mm, the structure of the intermediate layer is dispersed: the proportion of small-sized (with a cross-sectional area of less than 500 μm^2) β-phase (SnSb) crystals increases by 4 %, and their average size decreases from 31.1 and 5.4 μm compared to the initial state.

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