Plasma powder surfacing of babbitt alloys.

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Abstract

The various methods of babbitt coatings production have been considered. The main reasons that reduce the operating properties of babbitt alloys have been shown. The method of plasma-powder surfacing was offered for production of babbitt coatings. Experimental studies have shown that the using of plasma-powder surfacing is promising method for production of babbitt coatings and it leads to wear resistance improving while the friction coefficient is the same.

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Introduction

Anti-friction tin-based babbitt alloys are widely used in sliding bearings operating under extreme conditions. The structure of babbitt usually consists of soft matrix and reinforcing phase inclusions. The α-phase (solid solution of Sb and Cu in Sn) is the matrix and provides a good conformability, and a special surface micro-relief, which improves the supply by oil of friction sites and heat extraction from them. Solid phase inclusions (β-phase (SnCb) and γ-phase (Cu_3Sn)) ensure the high level of wear resistance [1, 2]. Babbitt alloys have the highest anti-friction properties among anti-friction alloys, but they have a low fatigue resistance limiting the range of anti-friction coatings thicknesses obtained from babbitt. The size and shape of reinforcing phase particles are the stress concentrators and lead to low values of fatigue resistance. According to [2, 3] the several times reduction of β-phase particles sizes in B83 babbitt increases the fatigue strength and damping capacity of babbitt.

Traditionally babbitt coating on the bearings are made by casting technologies. However, casting technologies have several disadvantages: low adhesive strength of the coating to the substrate, reinforcement's segregation over the castings cross section, susceptibility to defects such as shrinkage cavities and porosity, the necessity to keep a high allowance for machining. Recently new casting methods solving the some of these problems were developed. However, the problems such as low adhesive strength and high allowance for machining were not solved by casting methods to this day.

The methods of spraying and welding become more common for production of the anti-friction coatings on sliding bearings at the present time. These methods application can solve the problem of reinforcement's segregation, reduce the allowance for machining and improve the adhesion strength of anti-friction coating. Also the high cooling rate values in comparison with casting methods allow to obtain disperse structure, that promotes the fatigue strength increasing and, consequently, wear resistance improving. That is why spraying and welding methods are promising technologies for the sliding bearings production.

The plasma-powder surfacing technology is of interest for the sliding bearings production because it is easily automated, provides minimal penetration and ensures the stability of the deposited coatings quality. Therefore, this work is devoted to developing the plasma-powder surfacing technology of babbitt alloy on a steel substrate.

Experimental procedure

The anti-friction coating was deposited by plasma-powder surfacing. Steel plate (St3sp, GOST 380-2005) was a substrate. The backhand surfacing was done on direct current with straight polarity. The current value did not exceed 50A. The Castolin Eutectic EuTronic GAP 3002 AC / DC welding equipment was used to produce the coatings. Commercial powder LT29240 (Castolin Eutectic), which corresponded to $SnSb_8Cu_4$ according to ISO 4381-91 was used as filler material. The powder particle size was 100-150 μm (Fig. 1). The micro structure and chemical composition of deposited coatings were investigated by optical microscope Leica DMILM with Qwin program for image analysis and by scanning electron microscope FEI Quanta 3D FEG with equipment for X-ray spectroscopy. The deposited coatings subjected to rapid assessment of performance by tests for dry sliding friction according to "plug on disk" scheme (Fig. 2). The technological parameters of the experiment were: sliding speed - 0,39 m / s, the cycle time at a constant axial load - 10 min, the range of axial load - from 0,2 to 7,0 MPa. The steel plug (HRC> 45) was used as counter-body. The tested specimen (disk) was stationary.

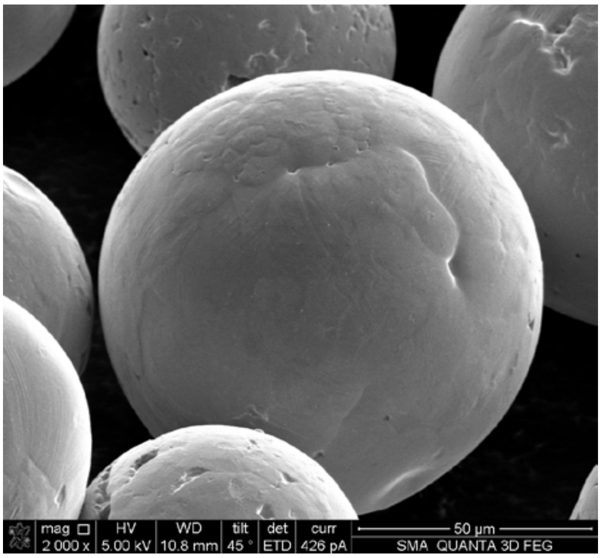


Fig. 1 Filler powder babbitt $SnSb_8Cu_4$ ISO 4381-91

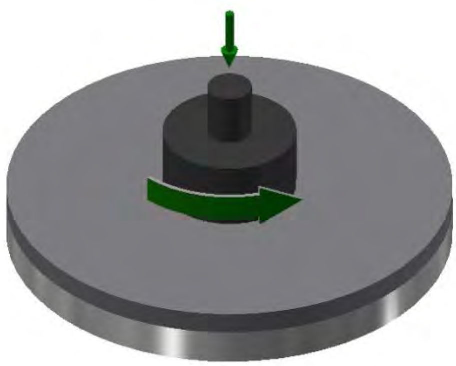


Figure 2. The "slug on disc" scheme for wear tests

The samples behavior during dry sliding wear tests was estimated on the friction coefficient and the volumetric wear rate (Iv), defined as the ratio of the volume of entrained material to the friction way.

Results and Discussion

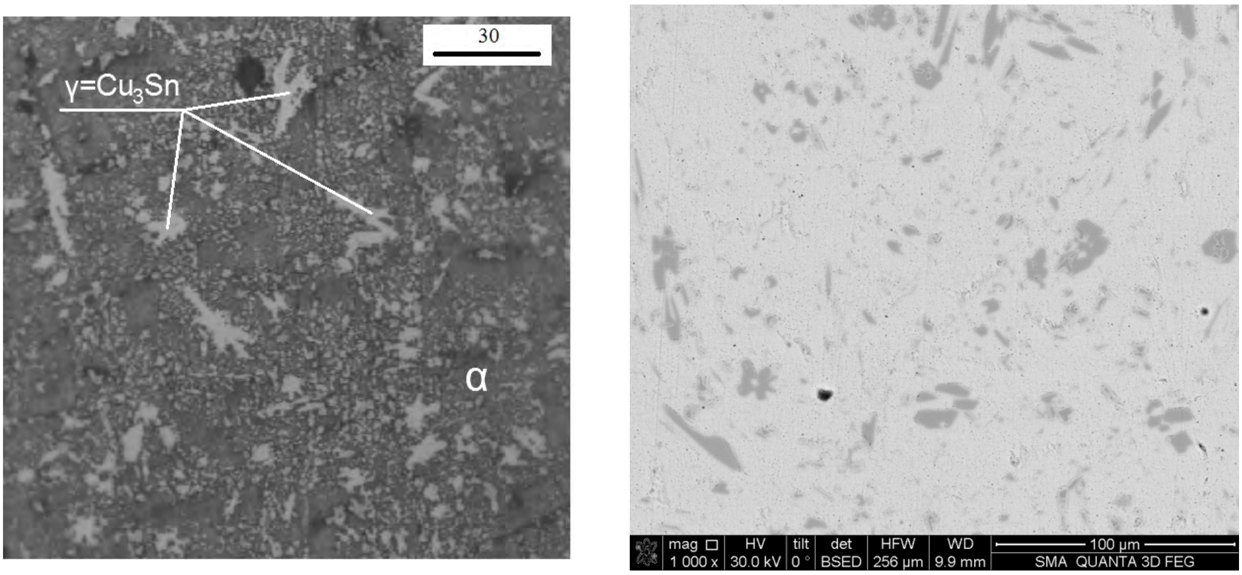
The deposited coatings with satisfactory formation were obtained as a results of the experiments (Figure 3).

a) b)

Figure. 3 The deposited coatings from babbitt alloys

The microstructure of the coatings is shown on Figure 4. It can be seen that the microstructure consists of the needle-like γ-phase (Cu_3Sn) particles in the α-phase matrix. Crystals of β-phase (SnSb) were not found, in the microstructure. It may be associated with the $SnSb_8Cu_4$ babbitt alloying degree (the solid solution of antimony in tin contains 9,4% Sb [5]).

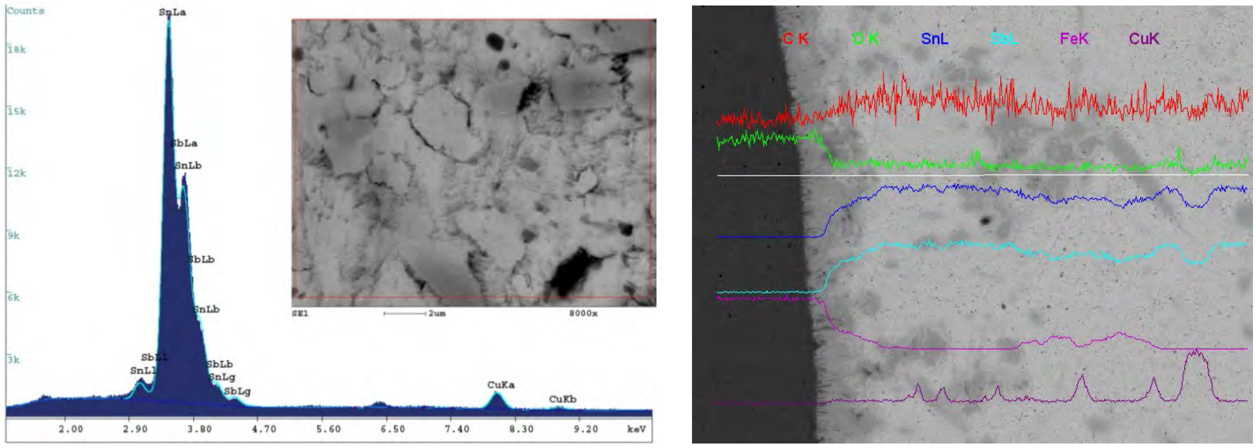
X-ray spectroscopy has shown the absence of alloying elements burning in deposited coatings during plasma-powder surfacing (Fig. 5a and Table 1). The slight mixing of the base and the deposited metal was observed in the fusion zone. The base metal (Fe) traces were observed in a small area (less than 2 μm) along the weld line (Figure 5b and Figure 6). These data allow us to recommend the method of plasma-powder surfacing for producing anti-friction babbitt coatings.



a) b)

Figure 4 Optical (a) and scanning-electron (b) microscopy

of the deposited coatings



a) b)

Figure. 5 Electron microscopy of the deposited coatings (a) and the fusion zone (b)

Table 1 Microprobe analysis of the deposited coatings

Element	Values		
	measured in experiment		according to ISO 4381-91
	wt %	at %	wt %
Sn	84,49	81,89	88,0 – 90,0
Sb	11,51	10,87	7,0 – 8,0
Cu	4,00	7,24	3,0 – 4,0

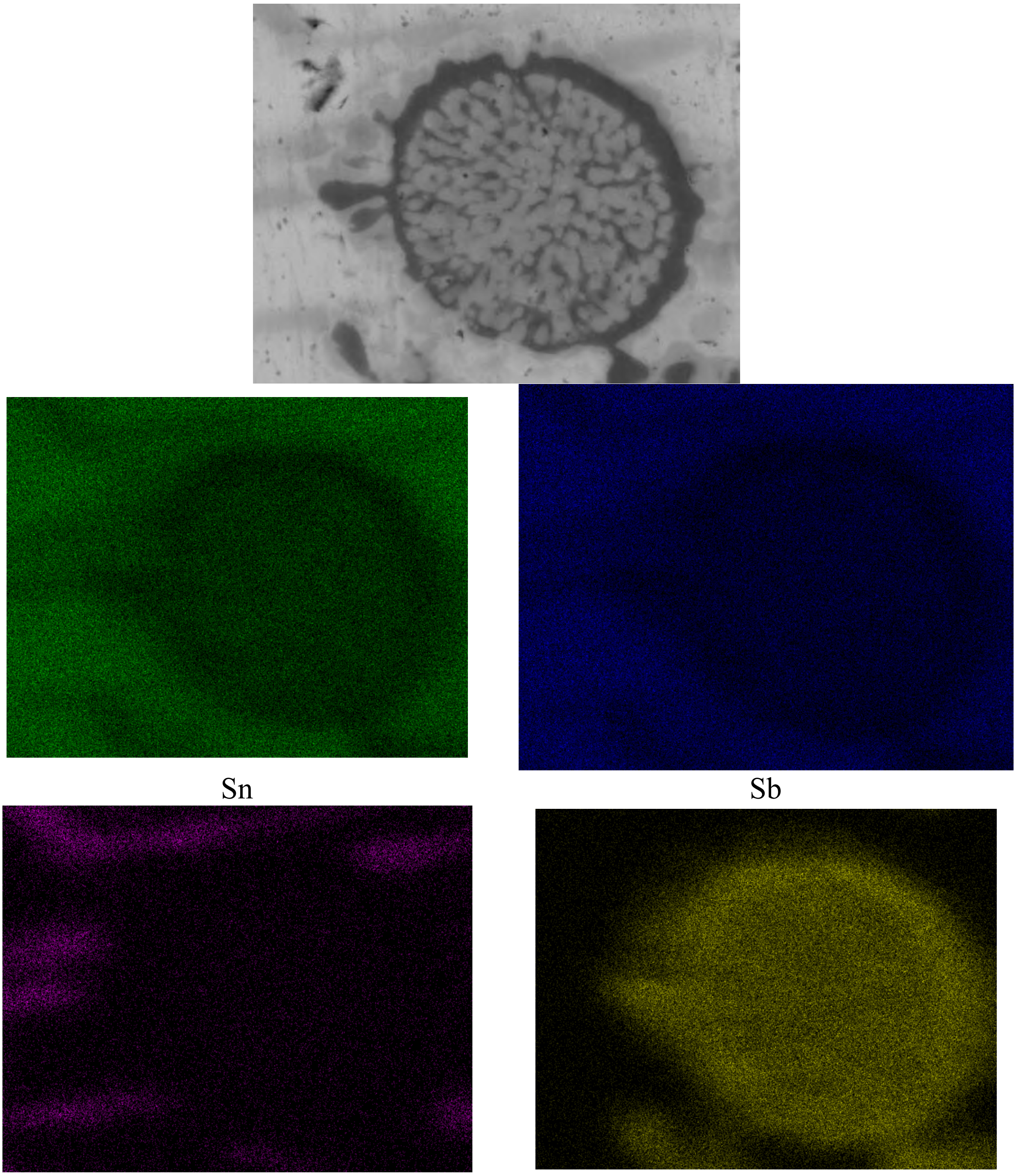


Figure. 6 Area of the deposited coatings near the fusion line,

shot in the characteristic radiation

Results of wear tests are shown in Table 2. These results were compared with the results of the same wear tests of industrial B83 babbitt samples obtained by casting technology. It is evident that the coatings obtained by plasma-powder surfacing have greater wear resistance compared with cast babbitt while the friction coefficient value is the same.

Table 2. Results of wear tests

Axial load, N	Industrial babbitt		Deposited babbitt surface layer	
	$I_v x 10^{-2}$ mm^3/m	$f_п/f_б$	$I_v x 10^{-2}$ mm^3/m	$f_п/f_б$
18	2,0	1	0,32	0,94
28	0,69	1	0,42	0,98
39	0,79	1	0,62	0,97
50	0,85	1	0,81	0,97
60	0,95	1	0,55	0,97

Conclusions.

1. The application of plasma-powder surfacing of $SnSb_8Cu_4$ babbitt alloy provides to obtain the deposited coatings without alloying elements burning and with minimal mixing of the main and the deposited metal.
2. Wear tests of the deposited coatings have shown that the coatings obtained by plasma-powder surfacing have greater wear resistance compared with cast babbitt while the friction coefficient value is the same
3. The obtained results demonstrate perspectivity of plasma-powder surfacing process for producing of surface anti-friction babbitt alloy coatings.

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