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Preparation and Properties of Bilayer Composite Materials of Cu-coated Fe and CuSn10

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Abstract

Bilayer composite materials of Cu-coated Fe and CuSn10 containing 0%, 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50% Cu-coated Fe were prepared in mesh belt sintering furnace. Microscopic pore morphology of materials was observed, bending strength was tested. Results show that, There is a good bonding between Cu-coated Fe and CuSn10, with the increase of Cu-coated Fe content from 0% to 50%, bending strength of bilayer composite materials increases.

Keywords: *Cu-coated Fe; CuSn10; bilayer composite*

1 Introduction

Oil-contained bearings are indispensable parts in the machinery industry, which is mainly used in high speed rotating machinery [1-2] and can be prepared by powder metallurgy (PM) technology [3-6]. As the pores exist, which are generated during PM technology, lubricating oil can be stored in PM Oil-contained bearings. Therefore PM Oil-contained bearings have the advantages of low cost and good lubrication performance, etc.

Because of its high content of Cu, which is 10wt%, the cost of CuSn10 alloy PM Oil-contained bearings is relatively higher than Fe alloy PM Oil-contained bearings. And because of its porous loose structure, the strength of CuSn10 alloy PM Oil-contained bearings is relatively lower than Fe alloy PM Oil-contained bearings.

To this end, researchers have developed a Cu-coated Fe composite materials by covering the surface of Fe powder with Cu powder to prepare PM oil-contained bearings[8], in order to improve the strength while further reduce the cost. However, the pore structure of Cu-coated Fe PM oil-contained bearings can not store lubricating oil well, which leads to poor lubrication performance and short service life.

For this purpose, we try to prepare bilayer composite materials containing Cu-coated Fe and CuSn10, in order to synthesize advantages both of high strength, low cost of Cu-coated Fe and good oil storage, lubrication performance of CuSn10, to develop high-performance bilayer composite material of Cu-coated Fe and CuSn10 for oil-contained bearings [9].

In this paper, bilayer composite materials of Cu-coated Fe and CuSn10 containing 0%, 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50% Cu-coated Fe were prepared via twice spreading of powder and hydraulic press with pressure of 650 MPa at room temperature, then sintered in mesh belt sintering furnace. Microscopic pore morphology of materials was observed, bending strength was tested.

2 Experiment Method

2.1 Experiment materials

CuSn10 powder and Cu-coated Fe powder were adopted. As shown in Figure 1. Firstly, CuSn10 powder was spread into the mold, then stirred slightly to make it evenly spread to form a layer of CuSn10 powder. Secondly, Cu-coated Fe powder was spread evenly onto the layer of CuSn10 powder. Green compact was prepared via hydraulic press with pressure of 650 MPa at room temperature. Composition proportion is shown at table 1.

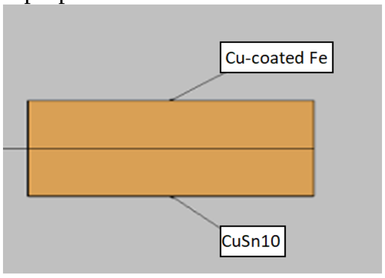

Figure 1 Specimens schematic diagram of bilayer composite materials of Cu-coated Fe and CuSn10

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Green compact were sintered in mesh belt sintering furnace. The sintering temperature was divided into 6 stages: 816℃ (18 min), 780℃ (18 min), 830℃ (18 min), 830℃ (18 min), 830℃ (18 min), cooling section (90 min), as shown at table 2.

2.2 Performance test

Microscopic pore morphology of sintered samples was observed by metallographic microscope. Three-point bending strength of samples were tested by universal testing machine, size of three point bending specimen is 24.6 mm long, 7.4-9.0mm wide, 8.2-8.6mm high, test span is 18mm.

3 Results and Discussion

3.1 Pore morphology of bilayer composite materials of Cu-coated Fe and CuSn10

Pore morphology of bilayer composite materials of Cu-coated Fe and CuSn10 is shown in figure 2- figure 4. As shown in figure 2(a), 3(a), 4(a), structure of CuSn10 is porous and loose with tiny pores evenly distributed on the matrix, which is a common pore morphology for CuSn10 PM oil-contained bearings. As the pores exist, lubricating oil can be stored to improve the lubrication performance of bearings, but on the other hand, strength of bearings is reduced.

As shown in figure 2(b), 3(b), 4(b), structure of Cu-coated Fe is filled with few and small pores. Obviously, it helps improve the strength of bearings, however, lubricating oil can not be stored, resulting in poor lubrication performance of bearings.

As shown in figure 2(c), 3(c), 4(c), there is a good bonding between Cu-coated Fe and CuSn10. Therefore, bilayer composite materials synthesize advantages both of high strength, low cost of Cu-coated Fe and good oil storage, lubrication performance of CuSn10.

3.2 Bending strength of bilayer composite materials of Cu-coated Fe and CuSn10

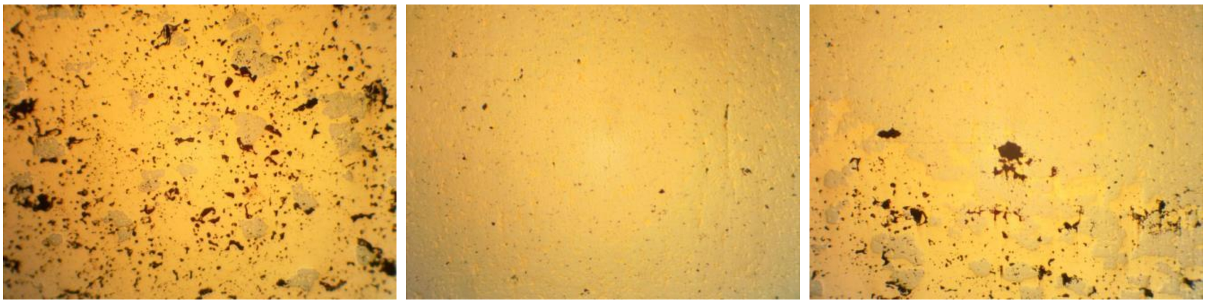
Bending strength of bilayer composite materials of Cu-coated Fe and CuSn10 is shown in table 3 and figure 5. As shown at table 3, size of three point bending specimen is 24.6 mm long, 7.4-9.0mm wide, 8.2-8.6mm high, test span is 18mm. As shown in figure 5, bending strength of bilayer composite materials shows increasing trend with the increase of Cu-coated Fe content from 0% to 50%. Especially, Bending strength of bilayer composite materialss containing 30wt% and more Cu-coated Fe are obviously higher than sample#1 prepared by CuSn10 alone. Moreover, bilayer composite materials containing 50wt% Cu-coated Fe have the highest bending strength of 432.65MPa, which is 18.66% higher than pure CuSn10 material.

Table 1 Specimens composition proportion (wt %)

Sample Number	Cu-Sn10 (g)	Cu-Fe (g)	Cu-coated Fe content (wt%)
	12	0	0%
	11.4	0.6	5%
	10.8	1.2	10%
	10.2	1.8	15%
	9.6	2.4	20%
	9.0	3.0	25%
	8.4	3.6	30%
	7.8	4.2	35%
	7.2	4.8	40%
	6.6	5.4	45%
	6.0	6.0	50%

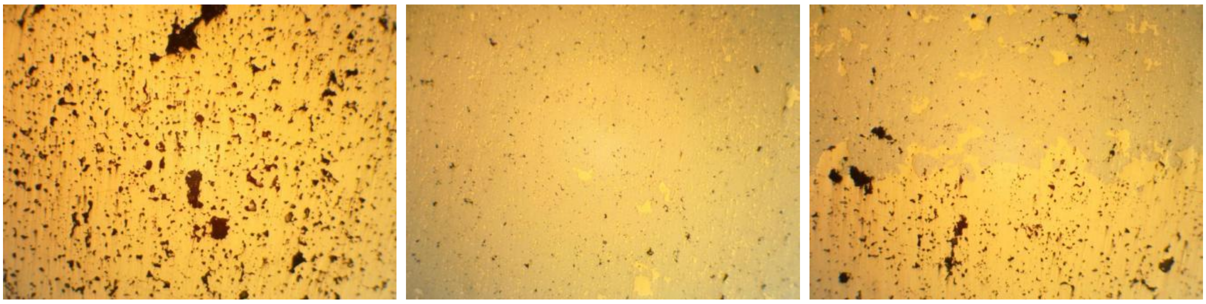
Table 2 Sintering process of specimens

Sintering stage	Temperature /℃	Time/min
	816	18
	780	18
	830	18
	830	18
	830	18
	cooling section	90



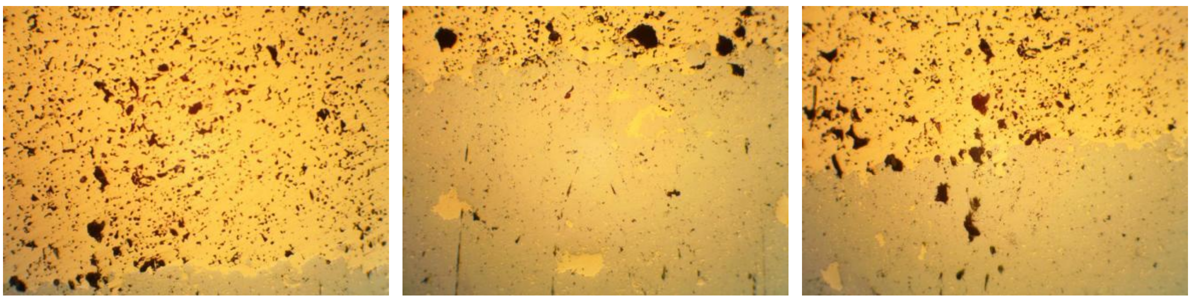
(a)Pure CuSn10 region (100X) (b)Cu-coated Fe region (100X) (c)interface bonding region (100X)

Figure 2 Pore morphology of bilayer composite materials of 5wt% Cu-coated Fe and CuSn10



(a)Pure CuSn10 region (100X) (b)Cu-coated Fe region (100X) (c)interface bonding region (100X)

Figure 3 Pore morphology of bilayer composite materials of 35wt% Cu-coated Fe and CuSn10



(a)Pure CuSn10 region (100X) (b)Cu-coated Fe region (100X) (c)interface bonding region (100X)

Figure 4 Pore morphology of bilayer composite materials of 50wt% Cu-coated Fe and CuSn10

Table 3 Bending strength of bilayer composite materials of Cu-coated Fe and CuSn10

Sample Number	CuSn10 (wt%)	F （N）	L (test span mm)	b (width mm)	h (height mm)	Bending strength (MPa)
	0%	7721	18	8.4	8.3	364.61
	5%	6477	18	8.5	8.3	298.65
	10%	8472	18	8.4	8.3	395.29
	15%	7500	18	8.5	8.3	345.82
	20%	6363	18	7.4	8.3	334.48
	25%	7784	18	8.9	8.6	319.29
	30%	9049	18	8.7	8.2	420.67
	35%	9564	18	9.0	8.2	422.58
	40%	9467	18	8.7	8.3	427.46
	45%	9367	18	8.9	8.2	421.67
	50%	9604	18	8.7	8.3	432.65

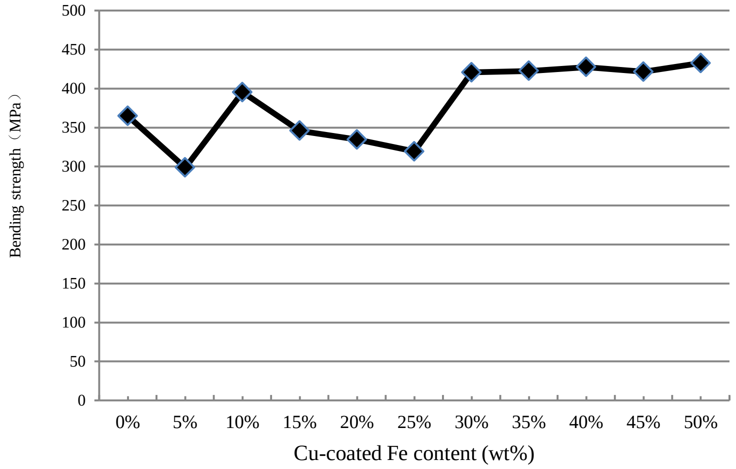


Figure 5 Bending strength of bilayer composite

4 Conclusion

Bilayer composite materials of Cu-coated Fe and CuSn10 with good interface bonding can be prepared via twice spreading of powder and hydraulic press at room temperature, which can synthesize advantages both of high strength, low cost of Cu-coated Fe and good oil storage, lubrication performance of CuSn10. (2) Bilayer composite materials containing 30wt% and more Cu-coated Fe show better mechanical properties, of which, materials containing 50wt% Cu-coated Fe have the highest bending strength of 432.65MPa, which is 18.66% higher than pure CuSn10 material.

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