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EXPERIMENTAL RESEARCH REGARDING THE OBTAINING OF FRICTION ELEMENTS

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ABSTRACT

Friction materials are used as bimetallic friction elements, consisting of a friction material layer sintered on a steel backing. Using the electron microscopy techniques (microprobe analyzer) some of the diffusion processes were investigated, at the interface friction material-steel backing, showing the important role of intermediate layers-electrodeposited copper and sintered Fe-Cu.

KEYWORDS: friction materials, copper X-ray scan, intermediate layer, microcomposition

1. Introduction

Sintered friction materials represent one of the typical applications of powder metallurgy.

The requirements imposed on friction materials are:

- high friction coefficient, with values which do not vary too much with the temperature,
- low abrasive wear and long friction period,
- good thermal conductivity resistance at the high temperatures,
- corrosion resistance,
- good running and continuous friction properties.

In order to realize all these properties, the modern friction materials have complex composite composition, containing metallic constituents which form the metallic resistance mass (copper, iron, steel, cast iron), the friction modifies (elements used in the friction surface cleaning) and lubricants. Iron-based friction materials are used in heavy-duty friction applications, which implies high temperatures of 500-700 C (frequently over 1000 C at the friction surface; e.g. airplane brakes).

It has to be mentioned that not the friction materials are produced, but the friction elements. A friction element can be represented by a friction disk or a friction plate, every one of them representing an assembly composed of a metallic backing and the friction material.

The metallic backing attends, without exception, all the sintered friction materials. Its presence is determined by the reduced mechanical resistance of the friction material.

The sintered friction material is composed by two-layer parts: a layer of a complex composition and an intermediate layer, for improving the contact between the friction material and the steel backing.

The role of the intermediate layer is that of facilitating the diffusion processes that occur during the sintering, in order to enssure a high quality brazing; for the same goal, the steel backing can be copper plated or electrolytic nickel-plated.

2. Experimental procedure

The used iron-based friction material has the following composition: 80% Fe, 5% Al_2O_3, 5% SiC, 5% graphite, 5% Pb. First the backing from low allowed steel has been plated with electrolytic copper.

The intermediate layer is a powder mixture: 50% Fe-50% Cu.

After the powder mixture homogenization, the mixture was deposited on the backing and compacted with a pressure of 500 MPa.

The sintering has been realized in hydrogen atmosphere, 1h at 1100 C.

The investigation of diffusion processes taking place at the interface friction material-steel backing, by the intermediate layers of sintered Fe-Cu and electrodeposited Cu on steel, as well as in the friction material itself. It was realized using the microstructure analysis in a cross-entry test section (fig.1).

The microstructure and microcomposition of a cross section were analysed, investigating in a first stage the diffusion of Fe, Cu, Pb by using a Phillips, SEM 515.

Fig.1. *BEI of the cross section (x 35)*

3. Results

The structure of the cross section through the analysed material is shown in figure 1. Only three of the initial layers can be observed (from the left side): steel backing, the intermediate Fe-Cu layer and the friction material.

The copper layer cannot be observed, owing to its complete diffusion, as results from Cu X-ray scan on figure 2, that shows the interface steel backing-intermediate layer.

Fig.2. *X–ray scan, Cu K*

Three constituents of different composition and contrast level were identified in the intermediate layer material structure (Figure 3 and Table 1). Lead segregation in bright contrast phase (2) can be observed, as well as copper diffusion in Fe-Cu compounds (1 and 3).

Iron-based composite friction material structure is shown by Figure 4.

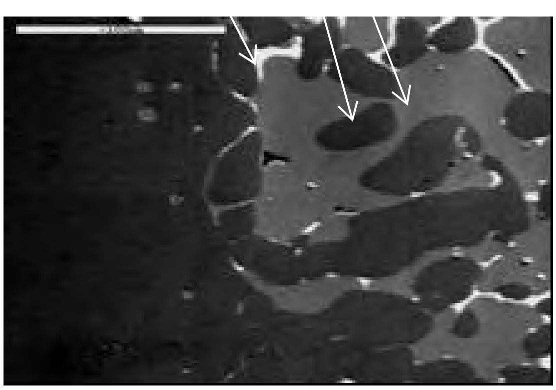

Fig.3. *BEI – Intermediate layer (x 500)*

Copper X-ray scan shows the intensive and uniform diffusion of this element, coming from the intermediate layer in the friction material.

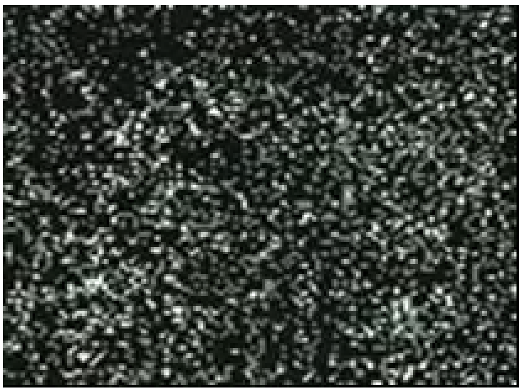

Fig.4. *X–ray scan, Cu K*

***Table 1.** EDS analyses results for intermediate layer*

Phase	Phase contrast	Chemical microanalyses, [wt. %]				
		Fe	Cu	Pb	Al	Si
1	Medium-grey	90.45	9.22	-	-	0.65
2	Bright	4.07	7.02	61.82	-	0.68
3	Bright-grey	5.31	92.70	-	-	0.36

4. Conclusions

The strong and continuous bond between the iron-based friction material and the steel backing is enssured owing to some diffusion processes, identified by microstructural analysis: electrodeposited Cu into intermediate Fe-Cu layer; Cu from the intermediate layer into friction material; Pb-liquid at the sintering temperature - from the friction material into the intermediate layer.

From the technological point of view, the two bonding layers-electrodeposited Cu and sintered Fe-Cu, are in a high degree necessary for a good quality adherence between the steel backing and the sintered friction material.

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