ELECTRICAL SLIDING CONTACTS IMPREGNATED WITH MAGNESIUM AND MAGNESIUM ALLOYS

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Introduction

Metal impregnated carbon/graphites and graphite materials are well introduced for several industrial applications like carbon strips in electrical locomotives and tramways, carbon brushes for various types of electrical motors and sliding materials for seals and bearings. The preconditions and the change in properties after impregnation with carbide- and non-carbide-forming metals were reported elsewhere [1].

Basically, carbon/graphites and graphites are impregnated with antimony, copper and lead for the use in applications where increased thermal and electrical loads are expected. The disadvantage of these materials are the environmental pollution and high weight, due to a bulk density of more than 2.0 g/cm^3.

In case of pantographs, the high speed traffic crossing all borders requires carbon strips out of light materials which are able to take high electrical loads.

The paper shows that materials impregnated with magnesium and magnesium alloys exhibit the required properties and are an excellent solution for these problems.

Experimental

The impregnations were carried out using vacuum/pressure vessels with a variation of three pressures between 2 MPa and 10 MPa in argon atmosphere. The temperatures varied according to the specific impermanent and were chosen slightly above the individual melting point.

Besides pure metal, also commercially available magnesium alloys containing zinc, aluminum, silicon and manganese were investigated. It should be noted that the use of pure magnesium requires special additional safety features. Different fine grained carbons with main differences in porosity and pore size distribution were selected as starting material.

The characterization of the materials was performed using standard investigations like pore filling degree, distribution of the impregnant, mechanical, electrical, physical and tribological properties.

Results and discussion

Table 1 shows the chemical composition of selected alloys. Although the large differences, especially in Al-content, greatly influence the wettability of the impregnant and the basic graphite material, it is possible to achieve 100 % pore filling degree if the impregnation parameters are individually adapted.

Table 2 shows the influence of an impregnation with the magnesium alloy of type B (see table 1) on the physical data of a carbon graphite material. The properties achieved with the other alloys or pure magnesium are quite similar if the impregnation parameters are correctly chosen.

Fig. 1 shows the flexural strength of carbon impregnated with non carbide forming metals and carbide forming metals. The higher strength of the materials with carbide forming metals is caused by the chemical reaction between carbon and the specific metal. The low electrical resistivity, even lower than a copper impregnated material, is also related to this chemical reaction.

The wear behaviour of these materials was tested at sliding speeds of 13 m/s and with peak-like electrical loads up to 400 A, the counter material being copper. Fig. 2 shows the wear results of the starting material to standard copper impregnated material as well as to one which is not impregnated.

Furtheron, the influence of a magnesium impregnated grade on the sliding partner is much less than that of non impregnated or standard impregnated materials.

Depending on the origin of the starting material, corrosion problems may occur. The impregnation with pure metal and/or special pretreatment of the material can minimize the corrosion effect, so that the use as wearing material will not be influenced.

Conclusion

These new types of ocmmercially available hybrid materials, carbon matrices impregnated with light metals, may open new fields for the industrial application of carbon materials. The high flexural strength combined with low weight and low electrical resistivity of these materials are very interesting properties for the use as electrical sliding contact. Main development activities are directed to such materials.

References

1. W. Huettner, R. Wolf and U. Wiessler, in Ext. Abstr., Carbon 1989, p. 482.

Element/ Alloy		A	B	C
Al	(%)	8.0 - 9.5	5.7 - 6.3	1.7 - 2.2
Zn	(%)	0.3 - 1.0	0.20 max.	0.10 max.
Mn	(%)	0.1 -0.3	0.27 min.	0.50 min.
Fe. max.	(%)	-	0.004	0.004
Cu, max.	(%)	0.05	0.008	0.008
Mg		rest	rest	rest

Table 1. Chemical composition of selected alloys

Property		Basic material	impreg-nated
Spec. electr. resistivity	(μΩm)	40	3
Shore hardness		65	93
Flexural strength	(N/mm^2)	25	110
Bulk density	(g/cm^3)	1.60	1.85
Pore volume	(%)	35	-

Table 2. Influence of an impregnation with a magnesium alloy on the physical data of a carbon graphite material

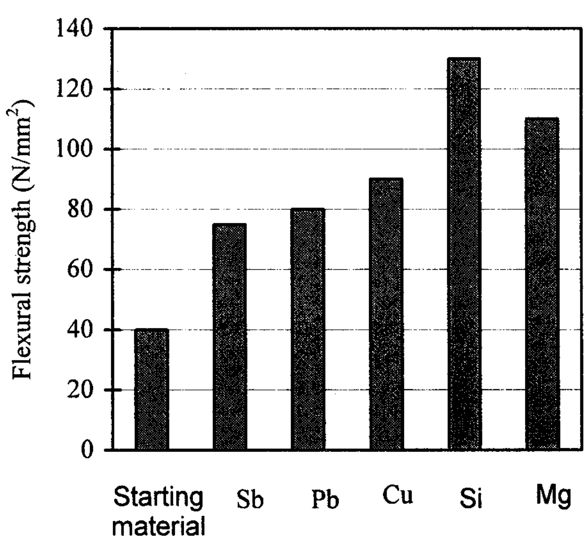

Figure 1. Improvement of flexural strength via metal impregnation

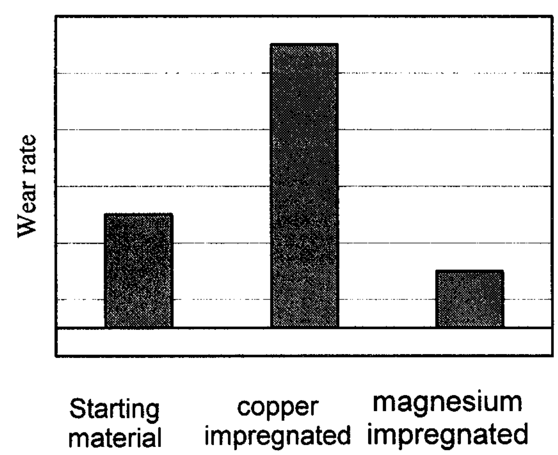

Figure 2. Wear behaviour of carbon and metal impregnated carbon materials