CORROSION RESISTANCE OF THE COMPOSITION MATERIALS SYSTEM (Cu–Al)–Mo, OBTAINED BY THE EB-PVD METHOD

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ABSTRACT

For development of new composition materials for the electric contacts, which would differ by high electric conductivity, mechanical properties, corrosive and erosion resistance in conditions of high temperature’s influence, it is necessary to decide the task of choice optimum of composition of matrix alloy and dispersion inclusions of hardening phases.

KEYWORDS: corrosive and erosion resistance, EB-PVD method

1. Introducing

One of the most widespread methods of material’s hardening is introduction of particles of the second phase to the metallic matrix. As is generally known from literature’s data, traditional low-alloyed alloys on the copper basis, bronzes, containing a chrome, aluminum or tin, insignificantly reduce electric- and thermal conductivity of copper matrix and substantially multiply its mechanical properties [1].

2. Results of researches

In this papers the researches of composition materials on the basis of low-alloyed copper matrix and hardening phase of molybdenum were conducted, which obtained by simultaneous evaporation from independent crucibles, with subsequent condensation of vapor stream on substrate, heated to the temperature 700±20 °C are submitted[2].

As alloying addition to the copper matrix the aluminum additions of which were brought into copper matrix within the limits of formation of hard solution in accordance with the state diagram for given components was used, that is the hard-solution’s hardening of copper matrix was used.

At alloying of copper matrix by an aluminum it’s maintenance did not exceed 6 %. Such composition was chosen on a next considering, from one side, taking into account insignificant reduction of conductivity of the system Cu- 6% Al and with, other, – at maintenance of aluminum more than 6 % in vacuum condensates the new phase appears with the parameter of lattice a = 0.87952 nm, accorded for the composition of Cu_9Al_4 phase. The presence of the second phase multiplies heterogeneity of the system and is instrumental in the decline of its corrosive resistance.

At maintenance in a copper matrix a 6 % Al middle width of grain diminishes from 35 mcm in condensates of pure copper to 15 mcm in condensates Cu– 6 % Al, being hard solution of aluminum in the copper. This electric resistance is $7.6 \cdot 10^{-8}$ Ohm·m on comparison with the copper $1.69 \cdot 10^{-8}$ Ohm·m, micro-hardness of condensates multiplied and during concentration of aluminum to 6 % exceeds more than micro-hardness of pure copper in 3 times. It enables to assume that composition materials on the basis of the matrix alloy Cu– 6 %Al with enough high electric conductivity and mechanical property it is possible to use for producing of electric contacts.

The choice of molybdenum for dispersion hardening phase is conditioned to those, that it suits, produced to the dispersion phase in a matrix on the basis of copper. From literature’s data, solubility of molybdenum in a copper in equal terms is practically was absence till 1300 K [3]. In addition, a molybdenum differs by the high temperature of melting, and low diffusive mobility in a copper matrix. It well moistens by copper, the corner of molybdenum moistening by pure copper is equal 0° [4], that indicates on high compatibility of dispersion inclusions of molybdenum with copper. The specific of important advantage of molybdenum’s using is its low value electric resistance ($5.7 \cdot 10^{-8}$ Ohm·m), which approximately in 3 times is more than for copper, therefore it follows to expect that introduction of molybdenum to the copper matrix will not strongly conductivity’s reduce of the system.

As solubility of molybdenum in a copper is insignificant, that introduction to condensate of the system Cu- 6 % Al additions of molybdenum results in formation of heterogeneous structure. According to the results of X-ray analysis, formation in condensates α- hard solution on the basis of copper and molybdenum was found out.

The values of periods of lattices of hard solution on the basis of copper, definite by a X-ray analyze, are showed in the table 1. Hard solution of matrix of copper-aluminum alloy have face-centered cubic lattice (fcc), similar to the pure copper the parameters of which are multiplied with the rise of maintenance of aluminum, that as atomic radius of aluminum on 10 % is more than atom's radius of copper.

Table 1

Composition of samples, mass.%			**Parameter of lattice *a*, nm**	
Cu	**Al**	**Mo**	**initial sample**	**after annealing, at 750°C, during 1 hour**
100	-	-	0.36189±0.00009	0.36182±0.00011
base	6	-	0.36592±0.00011	0.36589±0.00014
base	6	2	0.36574± 0.00009	0.36611±0.00026
base	6	4	0.36586±0.00022	0.36581±0.00024
base	6	6	0.36563±0.00014	0.36569±0.00015
base	6	10	0.36550±0.00015	0.36542±0.00032
base	6	12	0.36527±0.00013	0.36503±0.00025

Reduction of value of period of lattice for the system (Cu- 6% Al)- Mo with the increase of maintenance of molybdenum can be accounted for by formation of hard solution of aluminum in a molybdenum.

X-ray analyze are confirmed by electronic-microscopic researches (fig. 1). Researches of structure showed that size of grains of hard solution (Cu- 6% Al) in the system (Cu- 6%Al)- 2% Mo does not exceed 1.3 mcm.

In grains the dispersion particles of molybdenum, which size does not exceed 20-300 nm. Increase of molybdenum maintenance in the system (Cu- 6% Al)- Mo till 10 % results in the substantial growing of grains from 0.1 to 0.3 mcm, are evenly distributed, here the size of dispersion inclusions of molybdenum is multiplied to 50-2000 nm.

Corrosion resistance of the system (Cu- 6% Al) -Mo was studied by the gravimetric method in the distilled and plumbing water of middle inflexibility ($7\cdot10^{-6}$ mol-eqv./l) by standard method [5]. Time of test was 100 hours, measuring made each10 hours.

The gravimetric researches of corrosive resistance of composite (Cu- 6% Al) -Mo showed that insignificant maintenance of molybdenum (till 1 %) corrosive resistance same by level of the system Cu- 6% Al. With the increase of maintenance of molybdenum in the system (Cu- 6% Al)-Mo loss of mass diminish both in plumbing, and in the distilled water. This phenomenon is conditioned by reduction of dissolution of aluminum in connection with the presence of other metal with negative potential which competition and also participates in formation of galvanic couple with a copper. In behalf on such presentation the increase of concentration of molybdenum testifies in a corrosive environment (to water) after 100 hours of tests (table 2).

Table 2

Mode:	**Composition of environment, mg/l**			**ρ, Ohm·m**	**pH**
	Cu	**Al**	**Mo**		
initial plumbing water	1.94	0.05	3.5	$3.8\cdot10^{-6}$	7.43
plumbing water after 100 hours of test	1.71	0.034	9.74	$3.92\cdot10^{-6}$	7.77
initial distilled water	2.71	0.25	0.60	$9.27\cdot10^{-8}$	6.55
distilled water after 100 hours of test	2.33	0.27	3.05	$3.6\cdot10^{-7}$	7

Electrical conductivity of environment appropriately increases with the increase in solution of ions of molybdenum, pH increase because of that salts appearing at cooperation with carbon acid give the alkaline reaction. It should be noted that in the distilled water there is greater reduction of mass of standards, on comparison with plumbing water, in however the character of change of motion of curves depending on concentration of molybdenum remains identical for two environments.

Except for marked factors to reducing of losses of mass in the system (Cu- 6% Al)- Mo with the increase of maintenance of molybdenum has influence appearing on the surface of insoluble salts, which arise up because of cooperation of more electronegative aluminum with carbon acid appearing in investigation of dissolution of carbon dioxide from an atmosphere in water.

Conclusions

Introduction of molybdenum to the alloy (Cu-6%AI) is instrumental in the increase of mechanical properties and results in growing of structure's dispersion.

Corrosion resistance of the system (Cu- 6% Al)- Mo relies on maintenance of the entered components.

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