Change of electrochemical properties of amorphous metallic alloys by thermomagnetic modification

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Abstract – It was investigated influence of modification amorphous alloys based on cobalt and ferrum by variable magnetic field and heat treatment on their corrosion behavior in aggressive environment using electrochemical methods.

Key words – amorphous alloys, cobalt, ferrum, variable magnetic field, heat treatment, potentiometry, voltamperometry.

I. Introduction

Much attention to the study of change of physical and chemical properties of amorphous metallic alloys (AMA) based on ferrum and cobalt under act of different external factors was lately spared [1]. It can be used for special purpose modification of AMA, creation materials with usefull properties.

II. Experimental part

Research objects were ribbons of amorphous metallic alloys $Co_{73,6}Fe_{3,2}Mn_{3,2}Si_{5,0}B_{3,0}$ and $Fe_{78,5}Ni_{1,0}Mo_{0,5}Si_{14,0}B_{6,0}$ (got by the method of ultrafast flowspinning in G.V. Kurdyumov Institute for Metal Physics of the NAN of Ukraine, Kiev). Measuring of corrosive firmness of standards in 0,5 M aqueous solution of NaCl was carried out by the methods of chronopotentiometry and cyclic voltamperometry on the device Jaissle Potentiostat/ Galvanostat IPM PC-R. An elemental analysis was realized by the x-ray microanalyzer PEMMA- 102-02. Modification of initial alloys was carried out by using variable magnetic field (VMF) during (0,5÷3,0) h and by heat treatment (HT) at T = 473 K (1, 2 h). As a result of synthesis features distinguished contact (c) and external (e) sides of amorphous ribbon [2].

III.Results and discussions

Chronopotentiometric research of corrosive firmness of AMA $Co_{73,6}Fe_{3,2}Mn_{3,2}Si_{5,0}B_{3,0}$ (table 1) showed that duration of previous using of variable magnetic field had ambiguous influence. For the contact side of ribbon increasing of display in variable magnetic field to 3 h predetermines the change of eventual potential values (E_e) in an anodic side on 0,12 V, corrosive firmness rises. Less duration of using the variable magnetic field moves potentials in a cathodic side. For external side of ribbon increasing of corrosive firmness was observed at 0,5 and 3 h displaying. In case of AMA $Fe_{78,5}Ni_{1,0}Mo_{0,5}Si_{14,0}B_{6,0}$ display in the variable magnetic field promotes corrosive firmness both contact and external sides of ribbon.

Analogical researches of influence of heat treatment at T = 473 K (table 1) showed the decline of corrosive firmness of both samples, which had been testified by the change of E_e in a cathodic side.

TABLE 1

RESULTS OF POTENTIOMETRIC RESEARCH OF AMA RIBBONS IN 0,5 M AQUEOUS SOLUTION OF NACL, PRELIMINARY SELF-POSSESSED IN THE VARIABLE MAGNETIC FIELD AND ANNEALED AT T = 473 K

Treat-ment	Time, h	Side	E_0, V	E_e, V	ΔE, V	ν× 10^{-3}, V/s
$Co_{73,6}Fe_{3,2}Mn_{3,2}Si_{5,0}B_{3,0}$						
–	–	c	-0,41	-0,47	0,06	1,00
		e	-0,46	-0,52	0,06	0,92
VMF	0,5	c	-0,47	-0,67	0,20	5,80
		e	-0,41	-0,44	0,03	0,33
	1,0	c	-0.53	-0,55	0,02	3,50
		e	-0,49	-0,52	0,03	0,66
	2,0	c	-0,51	-0,54	0,03	0,33
		e	-0,47	-0,54	0,07	0,55
	3,0	c	-0,25	-0,35	0,10	0,50
		e	-0,35	-0,48	0,13	0,16
HT	1,0	c	-0,41	-0,52	0,11	0,66
		e	-0,45	-0,56	0,11	0,66
	2,0	c	-0,23	-0,53	0,30	0,16
		e	-0,21	-0,54	0,33	0,15
$Fe_{78,5}Ni_{1,0}Mo_{0,5}Si_{14,0}B_{6,0}$						
–	–	c	-0,52	-0,62	0,10	0,98
		e	-0,50	-0,66	0,16	0,96
VMF	0,5	c	-0,52	-0,60	0,08	4,36
		e	-0,49	-0,61	0,12	0,66
	1,0	c	-0,43	-0,52	0,09	1,50
		e	-0,39	-0,57	0,18	0,98
	2,0	c	-0,40	-0,50	0,10	0,23
		e	-0,45	-0,55	0,10	0,35
	3,0	c	-0,47	-0,55	0,08	0,50
		e	-0,48	-0,57	0,09	0,33
HT	1,0	c	-0,51	-0,68	0,17	1,20
		e	-0,45	-0,71	0,26	1,40

Research of influence of modification AMA standards on their electrochemical behavior in 0,5 M aqueous solution of NaCl by the cyclic voltamperometry method, at the additional loading cyclic scanning of the potential showed that influence of time displaying $Co_{73,6}Fe_{3,2}Mn_{3,2}Si_{5,0}B_{3,0}$ in variable magnetic field wasn't linear (table 2). The analysis of the parameters got at the protracted contact with an aggressive environment testified that protective layers are unsteady, as corrosion potentials moved in a cathodic side, and the values of corrosion currents increased. Similar dependence was traced in the case of being in variable magnetic field amorphous alloy $Fe_{78,5}Ni_{1,0}Mo_{0,5}Si_{14,0}B_{6,0}$.

Voltamperometric research change of properties of AMA $Co_{73,6}Fe_{3,2}Mn_{3,2}Si_{5,0}B_{3,0}$ after previous heat treatment (Fig. 1) showed, that onesentinel previous annealing resulted in activating of surface and moving values of corrosion potential in a cathodic side and increasing values of corrosion currents, and after 2 h – forming on the contact side of AMA protective layers that predetermines moving values of corrosion potential in an anodic side and some declining of corrosion currents.

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TABLE 2

ELECTROCHEMICAL PARAMETERS OF AMA CORROSION IN 0,5 M AQUEOUS SOLUTION OF NACL, SELF-POSSESSED IN VARIABLE MAGNETIC FIELD

Cycle	Side	Time, h									
		-		0,5		1,0		2,0		3,0	
		$-E_{cor}$, V	$i_{cor}\cdot10^{-4}$, A/sm^2	$-E_{cor}$, V	$i_{cor}\cdot10^{-4}$, A/sm^2	$-E_{cor}$, V	$i_{cor}\cdot10^{-4}$, A/sm^2	$-E_{cor}$, V	$i_{cor}\cdot10^{-4}$, A/sm^2	$-E_{cor}$, V	$i_{cor}\cdot10^{-4}$, A/sm^2
$Co_{73,6}Fe_{3,2}Mn_{3,2}Si_{5,0}B_{3,0}$											
1	c	0,75	2,6	0,92	4,2	0,82	8,2	0,67	5,6	1,03	10,4
	e	0,75	2,6	0,92	4,2	0,82	8,2	0,67	5,6	1,03	10,4
5	c	0,80	2,4	0,84	1,3	0,92	7,7	0,82	2,3	0,76	3,9
	e	0,80	2,4	0,84	1,3	0,92	7,7	0,82	2,3	0,76	3,9
10	c	0,86	8,9	0,88	1,4	0,92	2,4	0,96	6,9	0,93	3,2
	e	0,86	8,9	0,88	1,4	0,92	2,4	0,96	6,9	0,93	3,2
$Fe_{78,5}Ni_{1,0}Mo_{0,5}Si_{14,0}B_{6,0}$											
1	c	0,92	1,0	0,68	3,2	0,94	0,8	0,71	2,9	0,93	2,6
	e	0,94	0,4	0,86	0,7	0,94	0,4	0,74	1,4	0,85	0,5
5	c	0,93	2,3	0,89	0,6	0,93	0,7	0,87	2,5	0,93	1,5
	e	0,91	1,2	0,98	6,0	0,95	0,7	0,87	1,8	0,94	0,7
10	c	0,97	2,9	0,82	4,9	0,93	0,8	0,91	0,7	0,89	1,8
	e	0,97	1,8	0,98	2,4	0,93	1,6	0,87	4,4	0,96	1,0

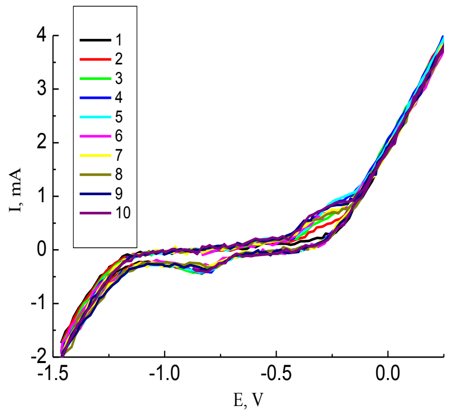

Fig. 1. Cyclic voltamperometry of contact side of AMA $Co_{73,6}Fe_{3,2}Mn_{3,2}Si_{5,0}B_{3,0}$ in 0,5 M aqueous solution of NaCl after 1 h anealling at T=473 K (1-10 number of cycle)

By the x-ray microanalysis it was determined the element composition of the samples of AMA $Fe_{78,5}Ni_{1,0}Mo_{0,5}Si_{14,0}B_{6,0}$ (table 3).

TABLE 3

ELEMENT COMPOSITION OF AMA $Fe_{78,5}Ni_{1,0}Mo_{0,5}Si_{14,0}B_{6,0}$

Treatment	Fe	Ni	Mo	Si	B
–	78,5	1,00	0,50	14,00	6,00
VMF (3 h)	81,42	0,63	1,07	5,18	11,7

Apparently being samples in variable magnetic field assists the considerable wedging out iron and boron, which connecting in Fe_3B.

Conclusion

It was found that it is possible to achive both activation and passivation of surface of AMA based on cobalt and ferrum by the selection of time displaying in the variable magnetic field and temperature-sentinel modes, that is important at their using as catalysts or at forming on them different superficial layers.

References

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