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Abstract

Full Text

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STUDY OF THE CONDITIONS FOR ISOLATING THE METALLIC COMPOUND Ni_3Al FORMED IN MULTICOMPONENT NICKEL ALLOYS

(Presented by Academician I. I. Chernyaev on 16 IX 1961)

This paper presents the results of a study of metallic compounds formed in alloys* of the system Ni–Cr–W–Mo–Al–Nb–Ti, isolated by the method of electrolytic dissolution. The chemical composition and heat-treatment conditions of the alloys are given in Table 1.

Table 1

Alloy No.	Heat-treatment conditions	Al	Nb	Ti	Cr	W	Mo	Ni
1	1200° –100 h	4.33	–	–	9.60	6.09	3.02	balance
2	1200° –100 h	3.86	3.00	–	9.50	6.00	3.00	balance
3	1200° –200 h	6.87	1.59	–	9.56	6.10	2.90	balance
4	1200° –200 h	8.47	–	–	3.43	2.41	1.12	balance
5	1100° –200 h	3.46	–	3.85	9.65	5.50	2.72	balance

The cast alloys were heated to 1100 or 1200°, held for 100 or 200 h, and cooled

in air.

To select conditions for the electrolytic dissolution of the indicated alloys, electrolytes widely used by various authors for isolating the γ' phase from nickel-base alloys were tested (¹⁻³). The comparative data obtained are presented in Table 2 and in Fig. 1.

Table 2

Results of chemical and X-ray structural analysis of anodic powders isolated from alloy No. 1

Electrolyte No.	Dissolution current density, A/cm ²	Weight of dissolved substance, g	Chemical analysis, %					X-ray structural analysis, %								
			Ni	Cr	Al	Mo	W	Total Ni	Cr	Al	Mo	W	Ni/Al data			
1	0.07530	0.4090	60	0.55	1.30	0.27	1.25	11.97	68.26	4.89	22.42	1.31	3.12	3.05	Ni ₃ Al	
2	0.07530	0.4018	42	0.55	1.27	0.27	1.21	11.72	68.22	5.00	22.36	1.33	3.09	3.05	Ni ₃ Al	
3	0.25	9	0.4028	51	0.54	1.29	0.27	1.21	11.82	68.20	4.85	22.57	1.32	3.06	3.02	Ni ₃ Al
4	0.05	45	0.3926	47	0.54	1.28	0.27	1.23	11.79	68.26	4.88	22.42	1.32	3.12	3.04	Ni ₃ Al
5	0.05	45	0.3602	44	0.55	1.27	0.26	1.22	11.74	68.31	4.98	22.30	1.28	3.13	3.06	Ni ₃ Al

* For the composition of the electrolytes, see the caption to Fig. 1.

As is evident from the data obtained (Table 2), from alloy No. 1 in all electrolytes an anodic powder is isolated, which is a solid solution based on the chemical compound Ni₃Al (in an amount of 11.8%), with a composition close to the stoichiometric one. The potential arising in

* The indicated alloys are being studied by L. I. Pryakhina for the purpose of constructing a phase diagram.

in the process of anodic dissolution of the alloy under study No. 1 at various electrolytic regimes, ranges from +1.25 V to +1.39 V (Fig. 1).

All the electrolytes used ensure preservation of the Ni₃Al phase during its electrolytic isolation. However, as the best one we selected the electrolyte with methanol (1), which completely prevents the hydrolytic precipitation of niobic and tungstic acids. Anodic dissolution of the alloys under study in this electrolyte takes place at an anodic-potential value from +1.35 V to +1.5 V (Fig. 2). Under these conditions the quantitative isolation of the Ni₃Al phase is also ensured.

According to the data obtained, the phase isolated from various alloys is a solid solution based on the chemical compound Ni₃Al, in which other elements are

dissolved (see Table 3). To check for the possible presence, in addition to Ni₃Al, of other phases (for example, Ni₃Nb), we subjected alloys containing niobium to anodic dissolution in another electrolyte intended for isolating Ni₃Nb (4, 5). In this case dissolution of the alloys occurs at a low value of the anodic potential (Fig. 3), and no anodic powder is isolated. This indicates that in the alloys investigated only one intermetallic compound, Ni₃Al, is formed, which is not isolated in the electrolyte tested.

To determine the amount of the Ni₃Al phase in the alloys, and also to establish the distribution of alloying elements between the basic γ -solid solution and the Ni₃Al phase, anodic dissolution of the alloys was carried out in the selected electrolyte (1), followed by chemical analysis of the anodic powder. From the data obtained, the distribution of alloying elements between the phases was calculated (see Table 4).

The γ -solid solution + Ni₃Al phase given in Table 4 corresponds to the composition of the alloy. The Ni₃Al phase represents the composition of the anodic powder, referred to the weight of the alloy-anode dissolved during the experiment. The composition of the γ -solid solution was calculated from the difference between the contents of the elements in the alloy and in the anodic powder.

Table 3

Chemical and X-ray structural analysis of anodic powders isolated in the electrolyte: 35 g citric acid, 5 g (NH₄)₂SO₄, 15 ml HNO₃ (1:4); 1000 ml CH₃OH, $i = 0.075$ A/cm²

Alloy No.	Chemical composition of anodic powder, %															Chemical composition of alloy, %	
	Ni	Al	Nb	Ti	Cr	W	Mo	sum	Ni	Al	Nb	Ti	Cr	W	Mo		Al
1	71.92	10.84	—	—	4.60	10.33	2.25	99.94	8.33	2.36	—	—	4.91	3.12	1.28	3.05	Ni ₃ Al, $a = 3.56$ kX

Alloy No.	Constituent phases of the alloys studied	Ni*	Cr	W	Mo	Nb	Ti	Al	Total
1	γ -solid solution + Ni_3Al phase	76.96	9.60	6.09	3.02	—	—	4.33	100.00
1	Ni_3Al phase	8.60	0.55	1.25	0.27	—	—	1.30	11.97
1	γ -solid solution	68.36	9.05	4.84	2.75	—	—	3.03	88.03
2	γ -solid solution + Ni_3Al phase	74.64	9.50	6.00	3.00	3.00	—	3.86	100.00
2	Ni_3Al phase	19.62	0.87	1.44	0.23	1.52	—	2.91	26.59
2	γ -solid solution	55.02	8.63	4.56	2.77	1.48	—	0.95	73.41

Alloy No.	Constituent phases of the alloys studied	Elemental composition (wt%)							
		Ni*	Cr	W	Mo	Nb	Ti	Al	Total
3	γ -solid solution + Ni_3Al phase	72.98	9.56	6.10	2.90	1.59	—	6.87	100.00
3	Ni_3Al phase	37.30	2.50	1.60	1.04	1.56	—	5.57	49.57
3	γ -solid solution	35.68	7.06	4.50	1.86	0.03	—	1.30	50.43
4	γ -solid solution + Ni_3Al phase	84.57	3.43	2.41	1.12	—	—	8.47	100.00
4	Ni_3Al phase	13.87	0.50	0.51	0.25	—	—	2.12	17.25
4	γ -solid solution	70.70	2.93	1.90	0.87	—	—	6.35	82.75

Alloy No.	Constituent phases of the alloys studied	Ni*	Cr	W	Mo	Nb	Ti	Al	Total
5	γ -solid solution + Ni_3Al phase	74.82	9.65	5.50	2.72	—	3.85	3.46	100.00
5	Ni_3Al phase	30.60	1.02	0.83	0.39	—	2.60	3.46	38.90
5	γ -solid solution	44.22	8.63	4.67	2.33	—	1.25	0.0	61.10

* The nickel content in the alloy was calculated by difference.

Fig. 1. Change in anodic potential as a function of the amount of electricity passed through the electrolyte during dissolution of alloy No. 1. Electrolytes: **1**—1000 ml CH_3OH , 35 g citric acid, 5 g $(\text{NH}_4)_2\text{SO}_4$, 15 ml HNO_3 (1.4); **2**—1000 ml H_2O , 35 g citric acid, 5 g $(\text{NH}_4)_2\text{SO}_4$, 15 ml HNO_3 (1.4); **3**—1000 ml H_2O , 10 g ammonium citrate, 100 g CuSO_4 , 10 ml H_2SO_4 (1.84)(2); **4**—1000 ml H_2O , 10 g ammonium citrate, 20 g CuSO_4 , 5 ml H_2SO_4 (1.84)(2); **5**—1000 ml H_2O , 9 g citric acid, 9 g $(\text{NH}_4)_2\text{SO}_4$.

Fig. 2. Change in anodic potential with time during electrolytic dissolution of the alloys (electrolyte: 1000 ml CH_3OH , 35 g citric acid, 5 g $(\text{NH}_4)_2\text{SO}_4$, 15 ml HNO_3 (1.4)). The curve numbers correspond to the alloy numbers.

Fig. 3. Change in anodic potential with time during electrolytic dissolution of the alloys (electrolyte: 1000 ml CH_3OH , 35 g citric acid, 50 ml HCl (1.19)). **1**—alloy No. 3; **2**—alloy No. 2.

The investigation carried out showed the reliability of the selected optimum regime for isolating the compound Ni_3Al from multicomponent nickel-base alloys containing Cr, W, Mo, Al, Nb, Ti. It has been shown,

that in the multicomponent alloys studied, one of the constituent phases is the metallic compound Ni_3Al .

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REFERENCES

1. R. B. Golubtsova, L. A. Mashkovich, DAN, **106**, No. 6 (1956).
2. N. F. Lashko, A. F. Likina et al., Collected Works, Central Scientific Research Institute of Technology and Machine Building, book 59, 1953.
3. N. I. Blok, A. I. Glazova et al., Zav. lab., **8**, 901 (1954).
4. R. B. Golubtsova, L. A. Nude, DAN, **130**, No. 2 (1959).
5. R. B. Golubtsova, L. A. Nude, Proceedings of the Central Scientific Research Institute of Technology and Machine Building, **11** (1960).

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