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Structure and Properties of Aluminum Alloys with Cerium, Praseodymium and Neodymium

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ABSTRACT

Chemical compositions and microstructure of Al – Ln (Ce, Pr, Nd) alloys and intermetallic compounds have been studied. The laws of change of thermophysical properties and thermodynamic functions of temperature according to composition of the alloys have been achieved. It was revealed the regularity of their changes depending on the composition. Melting temperature of intermetallic compounds of the system has been specified by Semi empirical method.

Key words: Microstructures, Thermodynamic properties, Alloys.

INTRODUCTION

Progress in many areas of science, engineering and technology practically possible in the presence of reliable information used in the study, design, and operation of materials and products. It is important to know the properties of individual structural components of alloys, and the results of their collegiate influences[1].

Heat capacity is one of the most important physical properties of solids, characterize the change of state of matter with temperature. The study of the heat capacity is one of the main research methods of structural and phase ïtransformations in alloys.Other physical characteristics of solids can be defined from the temperature dependence of the specific heat: the temperature and the type of phase transformation temperature. Debye energy of vacancy, the coefficient[1] heat capacity, and other thermodynamic functions[2-5].

EXPERIMENTAL

This paper presents the results of studies of the structure, thermal properties and thermodynamic functions of aluminum alloys containing 0.05, 0.1, 0.5, wt. % Cerium, praseodymium and neodymium. Thermophysical properties were in the temperature of ranges about 293-873 °C. Aluminum grade A99, Ce – Ce EO TU 48 - 295 -85, Pr - Pr M -1 -4-215 TU 48 - 72, Nd - H M –2 48 – 40 –205 – 72. M -2 TU48 - 40 -205 - 72 were used to study the research.

Digital The sample consists of a cylinder shape with 30 mm height and 16 mm diameter with drilled canal at one end, into the thermocouple. Thermocouples summed to gauge Digital Multimeter Multimeter UT 71 B , UT 71B, which produces direct fixation test results on a computer in a table. MS Temperature accuracy was 0.1 °C. The processing of the results of measurements were performed using the MS Excel. (Excel. Dependence of the cooling temperature (T) of the sample and then (τ)*:* T=f() were constructed using Sigma Plot . 0.998. Plot. Regression coefficient was not lower than 0.998.

RESULTS AND DISCURSION

Chemical composition of the alloys is determined by scanning electron microscope SEM series AIS 2100 (Korea). As an example, Figure 1 shows the intensity 0.5 ìàñ ñ . diffraction lines of the components aluminum alloy containing 0.5 wt. % Cerium. Difference between the specified composition and received information is little.

Microstructure of Alloys which were taken on a Canon microscope, has. certain direction, fine and uniform, indicating that improved mechanical properties. Within the investigated compositions, structure of alloys consists of a solid solution α - Al + eut. (α - Al + Al_{11} $Ln_{3.)}$ As the concentration of lanthanide share including the said eutectic aluminum solid solution increases (Fig. 2).

Figure 3. shows the temperature dependence of the specific heat of aluminum alloys with cerium and neodymium.temperature, regardless of the composition of the observed increase in the specific heat as aluminum and its alloys. Relative influence of the concentration of lanthanide on the specific heat capacity, observed slight reduction of the latter. This pattern is typical for aluminum alloys with praseodymium.

The temperature dependence of the cooling rate of aluminum alloys with praseodymium have been shown in figure 4. It shows the cooling rate of the alloys containing 0.05 wt.% Praseodymium metal with aluminum. Increasing addition of praseodymium, cooling rate increases. Tables 1-3 show the values of the temperature dependence of the enthalpy, entropy and Gibbs

Table 1: The temperature dependence of the enthalpy of cerium-aluminum alloys

T, º C	H, kJ / mol	T, º C	H, kJ / mol	T, º C	H, kJ / mol	T, º C	H, kJ / mol
	Al		0.05 Ce		0. 1 Ce		0. 5 Ce
	Al		0.05Ce		0.1Ce		0.5Ce
619.2	27.2649	615.7	27.3764	619.6	27.5355	618.2	27.3852
550.2	24.466	553.5	24.7681	553.5	24.5155	554.5	24.7192
479.2	21.7086	474.1	21.6389	470.8	21.5058	475.9	21.6289
390.4	18.4776	389.3	18.5234	387.8	18.4635	386.2	18.3467
321.8	16.1331	323.6	16.2557	324.3	16.2731	324.8	16.2367
255.6	13.9856	253.3	13.9579	255.5	14.0226	257.2	14.0307
205.4	12.427	205.7	12.472	204.2	12.4212	206	12.4355
169.6	11.3502	168.7	11.3534	167.7	11.3192	169.7	11.3415
119.5	9.8892	119	9.8984	119.5	9.9088	121	9.9193
71	8.5233	71.4	8.553	71.7	8.5579	70.7	8.502

energy for aluminum alloys with cerium, praseodymium and neodymium, respectively.

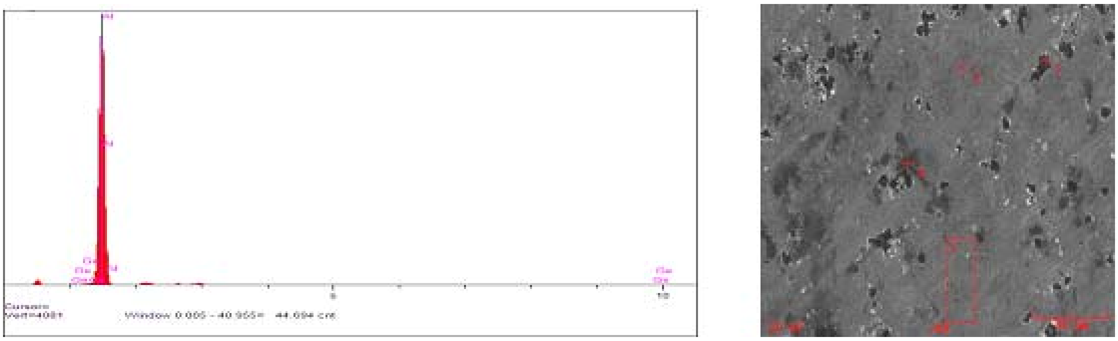
As can be seen on the tables at an elevated temperature is not dependent on the composition of all alloys is observed rise of the thermal properties. Temperature range which studied in the smallest value of the specific heat is observed in aluminum alloys with cerium. Depending on the atomic number of the lanthanides, from cerium, praseodymium and neodymium an increase in the value of the specific heat is observed. Aco the Tables, the investigated metals reduce the value of the temperature dependence of the entropy and enthalpy of aluminum.

Table 2: The temperature dependence of the entropy of aluminum alloys with praseodymium

T, °C	S, kJ. / Mol K Al	T,°C	S, kJ. / Mol K 0. 05 Pr	T, °C	S, kJ. / Mol K 0. 1 Pr	T, °C	S, kJ. / Mol K 0. 5 Pr
618.2	166.4286	619.1	166.7715	609.5	166.2042	618.9	166.121
550.2	163.1077	554.5	163.6233	554.5	163.5381	549.5	162.7477
479.7	159.5577	478.8	159.8243	476.9	159.6547	485.4	159.5625
431.4	157.1019	434.6	157.327	432.9	157.6977	433.5	156.8604
390.4	154.9411	385.4	154.9785	393.9	155.315	388.8	154.5351
329.4	152.0665	332.2	152.5177	332.7	152.2379	332.7	151.9671
280.1	149.5217	278.6	149.9236	280.8	149.6072	282	148.8982
228.8	146.0183	225.6	146.3546	228.5	146.3017	225.1	145.64
177.2	143.1423	176.2	143.419	175.2	143.2897	177.5	142.9476
129.6	138.0034	129.3	138.1399	127.1	138.138	128.8	137.6473
57.6	133.5463	57.7	133.7941	57	133.6767	57.5	133.2565

Table 3: The temperature dependence of the Gibbs energy of aluminum alloys with neodymium

T, °C	G, kJ. / Mol K Al	T, °C	G, kJ. / Mol K 0. 05 Pr	T, °C	G, kJ. / Mol K 0. 1 Pr	T, °C	G, kJ. / Mol K 0. 5 Pr
618.2	-120.878	618.2	-121.198	618.2	-121.151	618.2	-120.96
550.2	-109.674	550.2	-111.887	550.2	-112.073	550.2	-113.068
479.2	-98.2196	479.2	-99.3954	479.2	-99.9325	479.2	-100.856
431.4	-90.6515	431.4	-91.5755	431.4	-92.0907	431.4	-92.7999
390.4	-84.2548	390.4	-84.7181	390.4	-85.3831	390.4	-85.9911
337.6	-76.1496	337.6	-76.2417	337.6	-76.9879	337.6	-77.3477
292.7	-69.3788	292.7	-69.4117	292.7	-70.1774	292.7	-70.3846
234	-60.7039	234	-60.5344	234	-61.4454	234	-61.4373
188.7	-54.154	188.7	-53.9613	188.7	-54.799	188.7	-54.6657
114.6	-43.7341	114.6	-43.5101	114.6	-44.0448	114.6	-43.9307
57.6	-35.9926	57.6	-35.7383	57.6	-36.1112	57.6	-35.8754
24.8	-31.7237	24.8	-31.4761	24.8	-31.6987	24.8	-31.4407
12	-29.9927	12	-29.7868	12	-29.9303	12	-29.7181



	Units	Conc	Error2-sig	Intensity (c/s)	Line	Elt
	wt.%	99.506	42.198	4.541.03	Ka	Al
	wt.%	0.494	0.991	1.27	Ka	Ce
Total	wt%	100.0				

Fig. 1: The intensity of the diffraction lines of the components of aluminum alloy containing 0.5 % Cerium

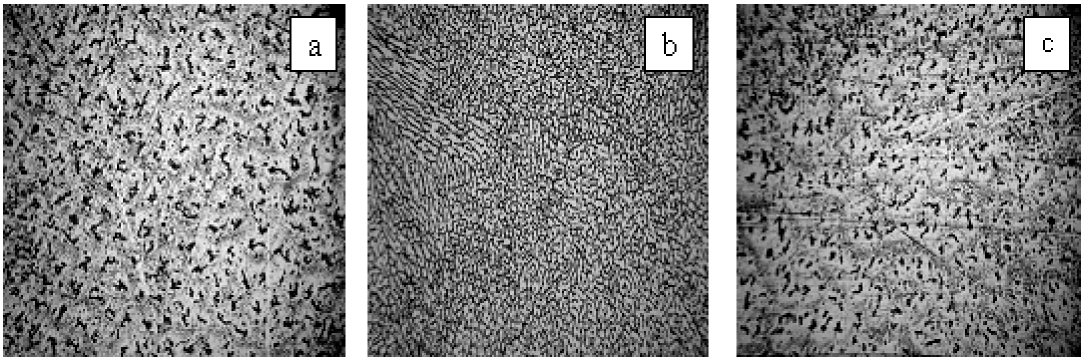


Fig. 2: The microstructure of aluminum alloys containing masses. %
a) 0.5% Ce - X500; b) 2,0% Pr X200 and c) 0.05% Nd X500

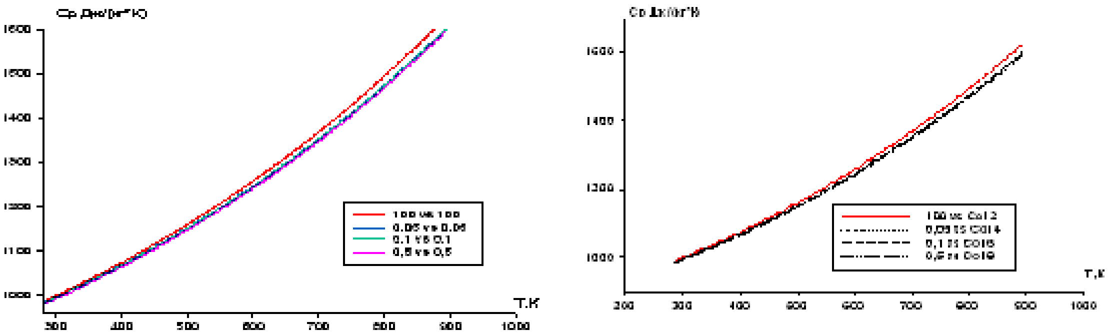


Fig. 3: The temperature dependence of the specific heat of aluminum alloys with cerium (a) and Nd (b)

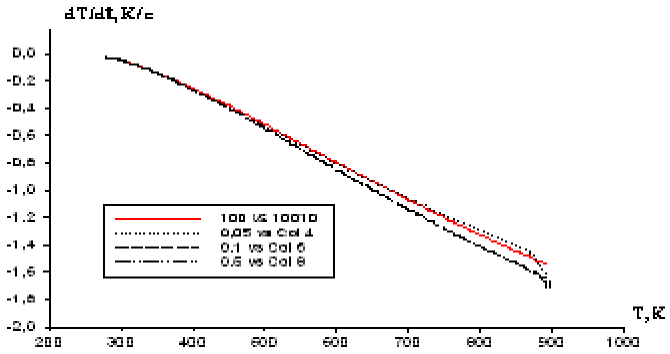


Fig. 4: Temperature dependence of the cooling rate of aluminum alloys and with praseodymium

CONCLUSIONS

Studying the microstructure of alloys, it is found that the structure of alloys consists of a solid solution of α - Al + eut. (α - Al + $Al_{11}Ln_3$) and by the method of cooling the temperature dependence specific heat capacity, entropy and enthalpy of aluminum alloys have been determined. It was found that increasing temperature regardless of an increase in the specific heat as aluminum and its alloys. The influence of the concentration of lanthanide on the specific heat is characterized by a slight decrease in the entropy and enthalpy of aluminum alloys.

REFERENCES

1. Zinoviev V. Thermophysical properties of metals at high. Temperatures, Moscow, Metallurgy, 1989, 384 p.
2. Zelikman A., Meyerson, GN Metallurgy of Rare Metals. - Metallurgy, 608s (1973).
3. Teylor C. Intermetallic compounds of rare-earth metals. -M., New York, 224p (1974).
4. Spedding D., Dahan A. Rare-earth metals. - M., New York, 324p (1965).
5. Reza Amini, Z. Nizomov, M. Razazi, I.N. Ganiev and Z.R. Obidov, *Orient J. Chem.* **28**(2): 841-846 (2012).
6. Rohlin LL Magnesium alloys containing rare earth metals. M.: Science, 188p (1980).
7. Ugai YA General and inorganic chemistry. - M: High. School., 527p (2004).
8. Kubashevsky O. Olkkok SB Metallurgical thermochimiya.-AM-M.: *Metallurgy*, 280p (1982).
9. Eight. VA Lebedev, VI Kober, LF Yamschikov Thermochemistry of alloys of rare earth and actinide metals. - Chelyabinsk, Metallurgy, 366p (1989).
10. Mondolfo LF Structure and properties of aluminum alloys. M. Metallurgy, 639 p (1979).
11. Elliot RP, The structures of binary alloys. Moscow: Metallurgy. In T. 472p (1970).