Thematic Section: Physicochemical Research. **Full Paper**
Subsection: Physical Chemistry. *Reference Object Identifier* – ROI: jbc-01/18-55-8-109
The Digital Object Identifier – DOI: 10.37952/ROI-jbc-01/18-55-8-109
Submitted on June 08, 2018.

Corrosion behavior of Al-Zr alloys and master alloys in NaCl solution

© **Alexander A. Filatov**,[1,2+] **Tatiana N. Ostanina**,[1,2] **Andrey V. Suzdaltsev**,[1]*
Natalia G. Molchanova,[1] **Alexander A. Pankratov**,[1] **and Yury P. Zaikov**[1,2]
[1] *Institute of High-Temperature Electrochemistry of UB RAS. Akademicheskaya St., 20. Yekaterinburg, 620137. Russia. Phone: +7 (343) 374-50-89. E-mail: info@ihte.uran.ru*
E-mail: fill.romantic@yandex.ru
[2] *Ural Federal University. Mira St., 19. Yekaterinburg, 620002. Russia.*
Phone: +7-800-100-50-44. E-mail: rector@urfu.ru

*Supervising author; +Corresponding author

Keywords: zirconium, aluminium, alloy, master alloy, corrosion resistance.

Abstract

The effect of zirconium content in Al-Zr alloys and master alloys on their corrosion resistance in 3% NaCl water solution at room temperature was studied by means of gravimetric and polarization methods. The structure of alloys and master alloys was additionally studied by scanning electron microscopy. It was found that the main part of zirconium in Al-Zr master alloys is represented by phases of an intermetallic compound with a size of 5 to 50 μm. According to the results of X-ray phase analysis, this compound is Al_3Zr. Based on the obtained results, the influence of the structure of alloys and master alloys, in particular, of the intermetallic compounds contained in them, on the corrosion rate of the samples was determined.

It has been established that homogeneous Al-Zr alloys are less prone to corrosion than master alloys with the inclusions of intermetallic compounds. However homogeneous alloys are less prone to passivation, which promote the corrosion resistance of the samples. The addition of 0.42 wt.% zirconium into aluminium reduces the corrosion rate of the alloy at the initial stages of testing, but with the increasing test durability the corrosion rate increases and becomes higher than that of high-purity aluminium. It was established that the sample with 5.5 wt.% of zirconium is the most susceptible to corrosion. This is caused by the presence of a large number of intermetallic compounds and the occurrence of corrosion galvanic couples. With an increasing zirconium content to 10 wt.% the corrosion of the master alloys is sharply enhanced during the first three days of testing. This is associated both with increasing area of intermetallic compounds and decreasing area of homogeneous alloy. It is leads to an increase in the density of the corrosion current. For longer tests, the corrosion rate of all samples decreases due to passivation. Among all master alloys containing intermetallic compounds, the sample with 11 wt.% zirconium shows the highest corrosion resistance. The relatively low rate of corrosion of this master alloy is maintained throughout the test period (28 days), which is associated with rapid passivation at the initial stage of the experiment.

References

[1] I. Polmear, D.St. John, J.-F. Nie, M. Qian. Light alloys. *Metallurgy of the light metals.* **2017**. 5th edition, Arnold, London. 544p. ISBN 9780080994314.
[2] V.M. Mironov, G.S. Vyshkvarko, G.G. Kitari, Proizvodstvo ligatur dlya aluminiyevyh i magniyevyh splavov. *Moskva; Leningrad.* **1936**. 84p. (russian)
[3] V.I. Napalkov, S.V. Makhov. Alloying and modifying of aluminium and magnesium. *MISiS: Moscow.* **2002**. 376p. (russian)
[4] D.V. Ogorodov, D.A. Popov, A.V. Trapeznikov. Methods of preparing aluminum-zirconium master alloy (review). *Trudy VIAM*. **2015**. No.11. P.2-11. (russian)
[5] P.S. Pershin, A.V. Suzdaltsev, and Yu.P. Zaikov. Recieving of Al-Si alloys in $KF-AlF_3-SiO_2$ melt. *Butlerov Communications.* **2015**. Vol.43. No.9. P.116-120. DOI: 10.37952/ROI-jbc-01/15-43-9-116
[6] P.S. Pershin, A.A. Filatov, A.Yu. Nikolaev, A.V. Suzdaltsev, and Yury P. Zaikov. Cathode processes during the synthesis of the Al-Zr alloys in $KF-AlF_3-Al_2O_3-ZrO_2$ melt. *Butlerov Communications.* **2017**. Vol.49. No.2. P.110-116. DOI: 10.37952/ROI-jbc-01/17-49-2-110
[7] L.B. Vedmid, S.N. Agafonov, Y.A. Avraamov, M.V. Ilyinykh, A.G. Merkushev, M.S. Plotnikov, A.F. Terlyga. Thermal analysis usage for process modelling of alumino-thermic zirconium reduction from oxide. *Rasplavy*. **2017**. No.4. P.289-293. (russian)

[8] A.A. Filatov, P.S. Pershin, A.Yu. Nikolaev, A.V. Suzdaltsev. Obtaining of Al - Zr alloys and ligatures during the electrolysis of KF – NaF – AlF_3 – ZrO_2 melts, *Tsvetnye Metally*. **2017**. No.11. P.27-31. DOI: 10.17580/tsm.2017.11.05.
[9] A.A. Filatov, P.S. Pershin, A.V. Suzdaltsev, A.Yu. Nikolaev, Yu.P. Zaikov. Synthesis of Al–Zr master alloys via the electrolysis of KF–NaF–AlF_3–ZrO_2 melts. *Journal of the Electrochemical Society.* **2018**. Vol.165(2). P.28-34. DOI: 10.1149/2.0571802jes
[10] E.M. Zhilina, S.A. Krasikov, S.N. Agafonov, L.B. Vedmid, and S.V. Zhidovinova.Thermodynamic and kinetic peculiarities of joint aluminothermic reduction of titanium and zirconium from oxides. *Butlerov Communications.* **2016**. Vol.45. No.1. P.130-135. DOI: 10.37952/ROI-jbc-01/16-45-1-130
[11] E.M. Zhilina, S.N. Agafonov, A.S. Russkih, S.V. Zhidovinova, V.P. Chentsov, and S.A. Krasikov. Aluminium interaction with multicomponent oxide system consisting of zirconium, titanium, silicon, iron. *Butlerov Communications.* **2017**. Vol.51. No.7. P.55-60. DOI: 10.37952/ROI-jbc-01/17-51-7-55
[12] Unified system of corrosion and aging protection. Metals, alloys, coatings, metal. Methods for removing corrosion products after corrosion tests: GOST R 9.907-2007. - Enter. 01.01.2009. *Moscow: Publishing house of standards*. **2007**. 20p. (russian)
[13] X. Wang, J. Wang, C. Fu. Characterization of pitting corrosion of 7A60 aluminum alloy by EN and EIS techniques. Trans. *Nonferrous Met. Soc. China 24.* **2014**. P.3907-3916. DOI: 10.1016/S1003-6326(14)63550-0