Thematic Section: Research into New Technologies. **Full Paper**
Subsection: Technology of the Inorganic Substances. *The Reference Object Identifier* – ROI: jbc-01/19-60-11-11
The Digital Object Identifier – DOI: 10.37952/ROI-jbc-01/19-60-11-11
Submitted on October 06, 2019.

Joint aluminothermic reduction of oxides Zr, Ta and Nb

© **Andrey S. Russkih**, **Sergey N. Agafonov**,* and **Artem A. Ponomarenko**+
Institute of Metallurgy of the Ural Branch of the Russian Academy of Sciences.
Amundsen St., 101. Ekaterinburg, 620016. Russia. E-mail: russkih_a_s@mail.ru

*Supervising author; +Corresponding author

Keywords: metallothermy, oxides, zirconium, tantalum, niobium.

Abstract

Alloys based on the Al-Zr system with insignificant Ta and Nb additives are in demand in the synthesis of complex alloys used to produce titanium alloys for aircraft and rocket technology. A common method for producing aluminum-zirconium alloys and ligatures is the out-of-furnace metallothermal reduction of zirconium from oxides and direct fusion of components. The practice of such methods has a number of significant disadvantages: poor separation of the metal and oxide phases, a low degree of extraction of the target component, the use of thermal additives, and the high cost of the resulting product. The solution to the problem may be a technology option where the temperature regime of the metallothermal reduction process is ensured both due to the heat of exothermic reactions and due to the additional supply of relatively inexpensive electrical energy.

In this work, we investigated the possibility of obtaining alloys using metallothermal reduction from oxides based on ZrAl with Ta and Nb additives. An experimental technique for producing an alloy is presented. The data of x-ray phase analysis (XRD) and chemical analysis of the alloy. as well as an analysis of the content of oxygen and nitrogen in the alloy. X-ray phase analysis showed the formation of the $ZrAl_2$ compound in all the studied alloys, as well as solid solutions $(Zr_4Nb)Al_3$, $(Zr_{0.8}Ta_{0.2})Al_3$, $(Zr_4Nb_{0.5}Ta_{0.5})Al_3$ corresponding to the added element, ZrO_2 is present in the 3 alloys, which tells us about not up to the reduced oxide Zr. These data are confirmed by analysis of the gas content in the alloy, where there is an increased oxygen content. The performed study can serve as a scientific basis for the development of promising metallothermal technologies for the production of rare metal alloys.

References

[1] M.I. Gasik, N.P. Lyakishev, B.I. Emlin. Theory and technology of ferroalloys production. *Moscow: Metallurgy.* **1988**. 784p. (russian)
[2] V.I. Napalkov, B.I. Bondaryev, V.I. Tararyshkin, M.V. Chukhrov. Ligatures for the production of aluminium and magnesium alloys. *Moscow: Metallurgy.* **1983**. 160p. (russian)
[3] S.N. Agafonov, S.A. Krasnikov, A.A. Ponomarenko, L.A. Ovchinnikov. Phase formation in aluminothermal reduction ZrO2. *Inorganic materials.* **2012**. Vol.48. No.8. P.927-934. (russian)
[4] R.J. Kematick, H.F. Franzen. Thermodynamic study of the zirconium-aluminum system. *Journal of Solid State Chemistry.* **1984**. Vol.54. P.226-234.
[5] A.V. Larionov, V.M. Chumarev, L.Y. Udoyeva et al. Modeling of aluminium thermal smelting of Al-Zr and Al-Zr-Mo-Sn alloys. *Metals.* **2013**. No.5. P.3-9. (russian)
[6] S.R. Schmidtt, H.F. Franzen. Nthalpies of formation in the tantalum-sulfur and tantalum-aluminum systems. *Journal of the less-common metals.* **1986**. Vol.116. P.78.
[7] L.B. Vedmid, S.N. Agafonov, Y.A. Avrahamov, M.V. Ilina, A.G. Merkushev, M.S. Plotnikov, A.F. Terlyga. Use of thermal analysis method for process of modeling of aluminium-thermal reduction of zirconium from oxides. *Melts.* **2017**. No.4. P.289-293. (russian)
[8] 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