Full Paper _____ *Thematic Section:* Research into New Technologies.
Reference Object Identifier – ROI: jbc-01/18-56-10-112 *Subsection:* Inorganic Chemistry.
The Digital Object Identifier – DOI: 10.37952/ROI-jbc-01/18-56-10-112
Submitted on September 26, 2018.

On the microhardness of the composite Ga-Cu-Sn obtained multivibration the processing idkategori mixture

© **Eduard Yu. Goyda**, **Igor E. Ignatiev**,[+] and **Alexey B. Shubin***
Laboratory of Physical Chemistry of Metallurgical Melts. FSBIS Institute of Metallurgy. Ural Branch of the Russian Academy of Sciences. Amundsen St., 101. Yekaterinburg, 620016. Russia. Phone: +7 (343) 232-90-14. E-mail: igx2@mail.ru

*Supervising author; [+]Corresponding author
Keywords: multivibration treatment, electroimpulse treatment, low-frequency treatment, copper and gallium alloy, copper-gallium-tin alloy.

Abstract

Synthesis of the gallium-based metallic pastes can be realized as usual by intensive mechanical mixing of solid and liquid components. “Classic” material of the powder part is Cu_3Sn intermetallide (ordinary used as spherical particles of small size fractions). The liquid part – as a rule- is eutectic Ga-Sn alloy (containing 13.6 wt.% Sn, Ga – the rest. Vibrational impact onto the capsule with the initial powder mix leads to the formation of paste. This paste solidifies during the components diffusion process (as a rule, in a few minutes) and reaches maximum strength in about 24 hours of the room temperature exposition. Here, a new modification of such “classic” method of gallium composite formation is described. The possibility of obtaining and synthesizing the composite material of the GA-Cu-Sn system by a new multi-vibration method of processing a mixture of the original solid and liquid components, combining in one process a low-frequency action with a frequency of 50 Hz and an amplitude of 15 mm and an electric pulse with a pulse frequency of 1000 Hz, a pulse duration of no more than 10-9 s and a single pulse power of 1 MW. The microhardness of the components of the resulting composite alloy consisting of Cu_3Sn particles in the shell of a solid $CuGa_2$ intermetallic compound and a binding matrix of a solid GA-Sn solution with embedded $CuGa_2$ particles is determined. The values of microhardness of composite samples created using new multi-vibration and conventional low-frequency methods of processing the initial mixture were compared. It was found that the microhardness of components designed to withstand mechanical stress as a result of multivibration treatment is higher than after low-frequency exposure for the same period of time. The conclusion about expediency of use of a new method at creation of composites of GA-Cu-SN system is drawn.

References

[1] I.E. Ignat`ev, E.A. Pastukhov, O.V. Romanova. A mathematical model of the impregnation of the melt metal powders using a vibrating effect. News of higher education institutions. *Powder metallurgy and functional coatings.* **2017**. No.1. P.4-10. (russian)
[2] I.E. Ignat`ev, E.A. Pastukhov, E.V. Ignat`eva. The method of obtaining alloy of low-frequency processing of melts/ in the book: Physical chemistry and technology in metallurgy, a collection of papers dedicated to the 60th anniversary of IMET UB RAS. Institute of metallurgy of the Ural branch of the Russian Academy of Sciences. *Ekaterinburg.* **2015**. P.122-130. (russian)
[3] I.I. Eduardovich, I.S. Sipatov. Particular properties of micron size powder particles. *Butlerov Communications.* **2013**. Vol.34. No.5. P.60-66. ROI: jbc-02/13-34-5-60
[4] I.E. Ignatiev, A.B. Shubin, and E.V. Ignatieva. Calculation of parameters of vibration mixing metal composites of copper-gallium. *Butlerov Communications.* **2015**. Vol.43. No.7. P.94-99. DOI: 10.37952/ROI-jbc-01/15-43-7-94
[5] A.B. Shubin, E.V. Ignatieva, and I.E. Ignatiev. Producing of the metallic compositions from the mixes of copper-containing powders and gallium melts: determination of optimum vibration treatment parameters. *Butlerov Communications.* **2016**. Vol.45. No.3. P.116-121. DOI: 10.37952/ROI-jbc-01/16-45-3-116
[6] I.E. Ignat`ev, A.B. Shubin. On the question of vibration parameters ensuring the production of copper-gallium paste. Proceedings of the scientific and practical conference with international participation "prospects for the development of metallurgy and mechanical engineering using completed fundamental research and R & D". *Yekaterinburg: Ural worker.* **2015**. P.359-361. (russian)

[7] E.Y. Goyda, V.V. Krimsky, I.E. Ignatiev, P.V. Kotenkov, A.V. Dolmatov, V.F. Балакирев, and E.V. Ignateva. The influence of unipolar nanosecond electropulse effects on the properties of the alloy Cu-1%Cr. The connection properties of the alloy with the duration of melt processing. *Butlerov Communications.* **2018**. Vol.53. No.2. P.145-152. DOI: 10.37952/ROI-jbc-01/18-53-2-145

[8] E.I. Ignat`ev, V.V. Krymsky, P.V. Kotenkov, V.F. Balakirev, E.A. Pastukhov, E.V. Ignat`eva. Method of production of composite alloys and device for its implementation. Patent RU 2625375 C2. Publ. **13.07.2017**. Bull.20. (russian)

[9] I.E. Ignat`ev, V.V. Krymsky, P.V. Kotenkov, V.F. Balakirev, E.A. Pastukhov, E.V. Ignat`eva. Joint and low frequency electric pulse treatment of metal melts. *Metallurg.* **2017**. No.4. P.83-86. (russian)

[10] I.E. Ignat`ev, V.V. Krymsky, P.V. Kotenkov, V.F. Balakirev, E.V. Ignat`eva. Multivibration treatment of melt. In the book: XX Mendeleev Congress on General and applied chemistry Abstracts. *Yekaterinburg.* **2016**. P.79. (russian)

[11] Yuan Yuan, Zhou Li, Zhu Xiao, Ziqian Zhao, Ziqi Yang. Microstructure evolution and properties of Cu-Cr alloy during continuous extrusion process. *Journal of Alloys and Compounds.* **2017**. Vol.703. P.454-460.