# NITROGEN IMPACT ON Cu-Zr-Al(-Ag) BASED MASTER ALLOYS

**Petru Hididis [1, a], Mircea Nicolaescu [2, b], Roxana Muntean [1, c], Norbert Kazamer [3, d], Cosmin Codrean [1, e], Viorel-Aurel Serban [1, f]**

*1"Politehnica" University of Timisoara, P-ta Victoriei, No. 2, Timisoara, Romania*
*2 National Institute for Research and Development in Electrochemistry and Condensed Matter, no 144 A, Paunescu Podeanu Street, Timisoara, Romania*
*3 Westfälische Hochschule, Neidenburger Str. 43, 45897 Gelsenkirchen, Germany*
*[a] petru.hididis@student.upt.ro, [b] mircea.nicolaescu@student.upt.ro, [c] roxana.muntean@upt.ro, [d] norbert.kazamer@w-hs.de, [e] cosmin.codrean@upt.ro, [f] viorel.serban@upt.ro*

The use of nitrogen as an alloying element and as a thermochemical treatment called Ønitriding is well known. On the other hand, nitrogen, that is considered as one of the most abundant non-metals from the atmosphere (among oxygen and hydrogen), is considered in metallurgical processes as accompanying chemical element. It is not purposefully inserted in the process and can affect up to 500-2000 ppm of alloys structure and properties. Positive effects of alloying with nitrogen have been recently reported [1-3]. This study is a research on the impact of nitrogen from a controlled atmosphere during production and investigations of Cu-Zr-Al(-Ag) master alloys that are forerunners for glassy alloys with same composition. Producing the master alloys in vacuum resulted in an absence of oxide layer. This allows for an easy diffusion of nitrogen on the master alloys. Effects of nitrogen on the Cu-Zr based ($Cu_{48}Zr_{47}Al_5$ and $Cu_{45}Zr_{45}Al_5Ag_5$) master alloys are investigated. The two button shaped samples were produced using the arc melting technique in an enclosed vacuumed chamber. Microstructural, thermogravimetric (TG) and mechanical investigations were done on both samples. Effects on nitrogen on the master alloys were investigated to observe its impact. To do so, TG analyses were performed in nitrogen atmosphere. The endothermic peaks suggest phase transformation that were later determined by XRD analysis and corresponds to the eutectoid transformation. The high temperature phase B2 CuZr decomposes in a eutectoid manner in two low temperature phases: $Cu_{10}Zr_7$ and $CuZr_2$. Nitrogen has a small atomic radius and a high solubility in some metals (e.g. 25% in Zr) produces an efficient cluster packing structure and thus the nucleation and growth of the crystalline phases can be suppressed and as a result the glass forming ability (GFA) can be improved [3]. Nitrogen presence leads to strong interactions with basic elements of the alloy as reflected by the large positive or negative heat mixing between N-Cu (71 kJ/mol), N-Zr (-78 kJ/mol) and N-Al (63 kJ/mol) binary pairs [3]. This newly formed atomic pairs with strong affinity change the local atom arrangements significantly thus leading to stability of the chemical and topological short-range orderings [3]. This is confirmed by the EDX that shows higher peaks for the Cu, Zr and especially Ag elements after TG. Also results from XRD after TG show strong presence of $N_2$, ZrN and AlN. Hardness increased on both samples after TG. A fair deduction is that the influence of nitrogen benefits and eases the production of glassy alloys with the same composition. Future studies will establish the optimal interval percent of nitrogen regarding master alloys. These master alloys will allow the production of Cu-Zr based glassy alloys. Such alloys found use in major engineering fields, i.e. consumer electronics, automotive products, medical devices, sporting goods etc. This is a consequence of their distinct mechanical, chemical and technological properties.

**References**

[1] B. Nabavi, M. Goodarzi, V. Amani, Welding Journal 94(2), 2015, 53s-60s

[2] L. I. D'yachenko, L. V. Fedina, Metal Science and Heat Treatment, Vol. 23, (1981), 668–670

[3] Z. Liu, R. Li, H. Wang, T. Zhang, Journal of Alloys and Compounds 509, (2011), 5033–5037