Nanocomposites and nanomaterials

Hollow metallic particles formation through the spark-erosion of alloys in cryogenic liquids

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Formation of the micron-sized hollow metallic particles of some B2 intermetallic compounds, glass-forming Zr-base alloy and pure Ti, Ni obtained by spark erosion method in liquid nitrogen and argon are considered. Hollow particles sized 10÷20 microns have a spherical shape, indicating their origin from molten droplets. Irregular shaped pores sized about of third of part of the particle diameter were found in Ti particles obtained in liquid N_2. Multi-event solidification on the particles surfaces have been observed presumably due to the rapid TiN nitride formation on the surface of molten particles. Thus such kind of pores appear as a result of volume shrinkage through solidification that commences from the surface.

In Ti-Ni [1], Ni-Al[2], Cu-Al-Ni[2], Zr-Ni-Cu-Ti-Al and Ni one large or several middle well-rounded pores have been found. Nucleation of solid phase occurs inside the liquid particles. Other peculiarity is a sponge-like structures on the periphery of craters on the surface of alloys pieces that appear during spark-erosion. As an extreme case of the hollow particles is the bubble-like particles in Ni-Mn-Ga [3] and Ni obtained in liquid N_2. Such morphology as well as sponge-like structures presume explosive boiling mechanism of hollow particles formation. Mechanisms explains two types of nano-sized particles one of about several decades nanometers are formed due to explosion of molten particles while smallest sized less than 10 nm are formed as a results of condensation vapor phase.

1. *Monastyrsky G.E., Ochin P. at all* Effect of particles size on chemical composition of Ti-Ni-base spark erosion powder obtained in liquid argon, Chemistry of Metals and Alloys, // Chem. Met. Alloys -2011.-**4**.-P. 188-199.
2. *Monastyrsky G.E., Ochin P. Gilchuk A.V. at all* The role of nano-sized fraction on spark plasma sintering the pre-alloyed spark-erosion powders // Journal of Nano- and Electronic Physics, -2012.-4:1.**P**.1007-1-7 .
3. *Ochin P. Gilchuk A.V.*, *Monastyrsky G.E. at all* Martensitic Transformation in Spark Plasma Sintered Compacts of Ni-Mn-Ga Powders Prepared by Spark Erosion Method in Cryogenic Liquids // *Mat.Sci. Forum*, -2013.-**738-739**.-P. 451-455.