TOWARD NEW FRONTIERS FOR COMPOSITE MATERIALS

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Abstract

Scientific contributions that are presented follow the latest evolutions from the classic concept of composite material with light metallic matrix discontinuously reinforced with micron-sized particles, produced by mean of conventional casting or powder metallurgy techniques, toward new scientific frontiers.

In this respect, the *1st Chapter* of the thesis syntheses the scientific contributions for development of Ti-based composites with amorphous matrix and crystalline secondary phases for biomedical applications. The first direction is represented by the development of a new Ni-free titanium alloy with composite amorphous/crystalline structure, containing minor addition of Ga. The new $Ti_{41.5}Zr_{2.5}Hf_5Cu_{37.5}Ga_{7.5}Si_1Sn_5$ alloy fabricated by mean of suction casting method has a very complex structure of an amorphous/nano-crystalline composite. The second direction that was followed was represented by development of new Ti-based composites without any Cu-content, for applications as orthopedic implants, considering the well-established cytotoxic effect of this element, which was replaced with Ag. The newly designed alloy $Ti_{42}Zr_{10}Pd_{14}Ag_{26}Sn_8$ fabricated by ultra-rapid melt cooling shows a complex microcrystalline structure, with residual amorphous matrix. The new alloy has some promising features for use as biomaterial, considering the bactericidal effect of metallic Ag and the composite amorphous – crystalline character with potential for high mechanical properties.

The *2nd Chapter* presents the scientific contributions that resulted in development of new porous materials, considered to be composite materials by some leading opinions. A new biomaterial with Ti-based amorphous matrix was fabricated using an advanced technique that combines melt-spinning of amorphous ribbons followed by powder metallurgy processing. Resulting $Ti_{42}Zr_{40}Ta_3Si_{15}$ amorphous material has some outstanding properties, having mechanical properties close to human bone.

New processing frontiers for fabrication of Al-based composites reinforced with ceramic particles are summarized in the *3rd Chapter.* Researches in this field have been focused mainly on new hybrid Al-based composites produced by mean of innovative fabrication methods. The new composites have two types of reinforcements, the first one is embedded alumina, while a second fraction of alumina particles is produced in-situ.

The *4th Chapter* illustrates with examples the application of computerized image processing to the analysis of reinforcement distribution for some discontinuously reinforced aluminum matrix composites. This advanced investigation technique allows objective interpretation of microstructural images obtain by light or electronic microscopy, as well the use of statistical methods for characterization and optimization of particle distribution.

The scientific achievements in the field of materials science and engineering were published in prestigious journals with large impact on the research community, such as *Intermetallics, Acta Biomaterialia, Acta Materialia, Materials, Journal of Thermal Analysis and Calorimetry, Metall, Journal of Magnetism and Magnetic Materials*, or included in the proceedings of international conferences.

The full abstract at:
http://www.upt.ro/img/files/2015-2016/doctorat/abilitare/nicoara/Abstract_thesis_Mircea_Nicoara_EN.pdf

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