DESCRIPTION FOR THE GENERAL PUBLIC (IN ENGLISH)

Iron based metallic glasses, due to their excellent soft magnetic properties are suitable materials for many electrical devices such as electronic measuring and surveillance systems, magnetic wires, sensors, band-pass filters, magnetic shielding, energy-saving electric power transformers. In the case of a strong temperature rise, uncontrolled crystallization would take place and some of their properties (usually the both: soft magnetic and mechanical properties) would be lost. Indeed, the production of the controlled microstructure after devitrification of the amorphous state has become of special interest for technological applications. In fact, the thermal stability of soft magnetic FeSiB metallic glasses is still widely studied. A suitable heat treatment, which leads amorphous material to partially crystalline state may provide, in some cases an improvement in properties. To optimize partial devitrification, a detailed understanding of the crystallization process is required.

The transformation process of the material from a glassy to a crystalline state contains many preparatory stages before the crystallization process. It was already proved that the excellent soft magnetic properties of nanocrystalline materials are attributed to the microstructure consisting of α-Fe(Si) fine grains embedded in a residual amorphous matrix. Several authors reported that the Fe-Si-B ternary system (without Cu and Nb alloying additions) can be nanocrystallized by annealing at low temperatures, but it requires prolonged annealing (~300 h) due to sluggish kinetics, what is not suitable to produce nanocrystalline material on a industrial scale. In fact, variable rapid heating methods were used for the partial devitrification of amorphous materials.

We already experienced, that laser treatment of the amorphous metallic materials leads to the localized, nonequilibrium crystallization processes. Because of the very rapid heating and cooling rates involved in laser treatment there is no experimental method, which lets to simulate directly, "in situ", the thermal process proceeding under the laser beam. Pulsed laser crystallization is cheap and fast, but the spontaneous nucleation, of the crystalline phases occurring randomly in the amorphous material is difficult to control. A control of the density and distribution of nucleation sites is required for improving the properties of nanocrystalline materials. In recent years laser interference patterning, known also as a direct laser interference lithography (DLIL) is significantly developed. It allows the production of very precise periodic nanostructures, uniformly distributed over large areas, and is a fast developing field of investigations with applications in many technological areas. This method enables in a direct manner to create surface structures in the micro- and sub-micron scale with a well-defined long range order.

Indeed, the main objective of the project is to give an insight into fundamental understanding of the influence of laser fluence, number of laser pulses (shots number) and their frequency, as well as, and their periodic distribution on the amorphous ribbon surface, on the crystallization (devitrification) process during the interference laser heating .

In order to prove the thesis proposed, the samples of various structures will be produced by using Q-switched Nd:YAG laser radiation for the ID and 2D interference laser heating of two amorphous FeSiB and FeCuNbSiB alloys. The samples will differ in the spatial distribution of heated areas (lines or dots) and their size. Next, the samples will be characterized in terms of microstructure, magnetic and mechanical properties. Structural changes in amorphous matrix will determined by X-ray diffraction, by scanning and transmission electron microscopy and atomic force microscopy. The proposed project is of high importance for the development of the scientific field which is materials engineering.

The results of the project will create the scientific basis for the application of the interference laser heating, originating in periodically distributed nanostructured areas in amorphous matrix, to develop new materials with specific magnetic and mechanical properties.

It can be expected that results of such complex studies that are the objective of this project will give in the materials scientists hands novel instrument for the development of new laser technologies, in which the interference pulsed laser heating will be used for treatment of amorphous materials including bulk metallic glasses.