Synthesis and Investigation of Biocompatible and Biodegradable Materials

Maintenance and improvement of human health is and always will be one of the main priorities of science. These tasks require not only new medical methods but also new materials. Therefore, two types of the materials: biocompatible crystalline (based on Ti) and biodegradable amorphous alloys were investigated in this project.

One part of the work was concerned to the biocompatible crystalline (based on Ti). In this regard was studied the novel α+β type Ti-based alloys. In this regard, the structural and mechanical properties of α+β Ti-Fe-Cu-Sn alloys are investigated. The effect of concentration of the alloying elements and other parameters like regimes of rolling and dual-axial forging operation on the microstructure and mechanical properties were thoroughly investigated. The Ti94Fe1Cu1Sn4 alloy with most promising mechanical properties was subjected to thermo mechanical treatment. But already in as-cast state it has already acceptable mechanical properties (Fig. 1, a). For example, the alloy exhibited tensile strength and tensile plasticity of about 920 MPa and 7% respectively with an elastic modulus of about 75 GPa. Such good tensile mechanical properties are explained by the optimal volume fraction balance between α and β phases texture alignment (Fig. 1, b-d). In this regard, from this alloy was obtained tubes samples, for the further biocompatible composites preparation (Fig. 1, e) and obtained powders for the 3D printing of the porous structures (Fig. 1, f). In frame of this investigation area 2 research papers, with the acknowledgement of the research project, including the paper about the investigation of high-entropy alloys were published [1, 2].

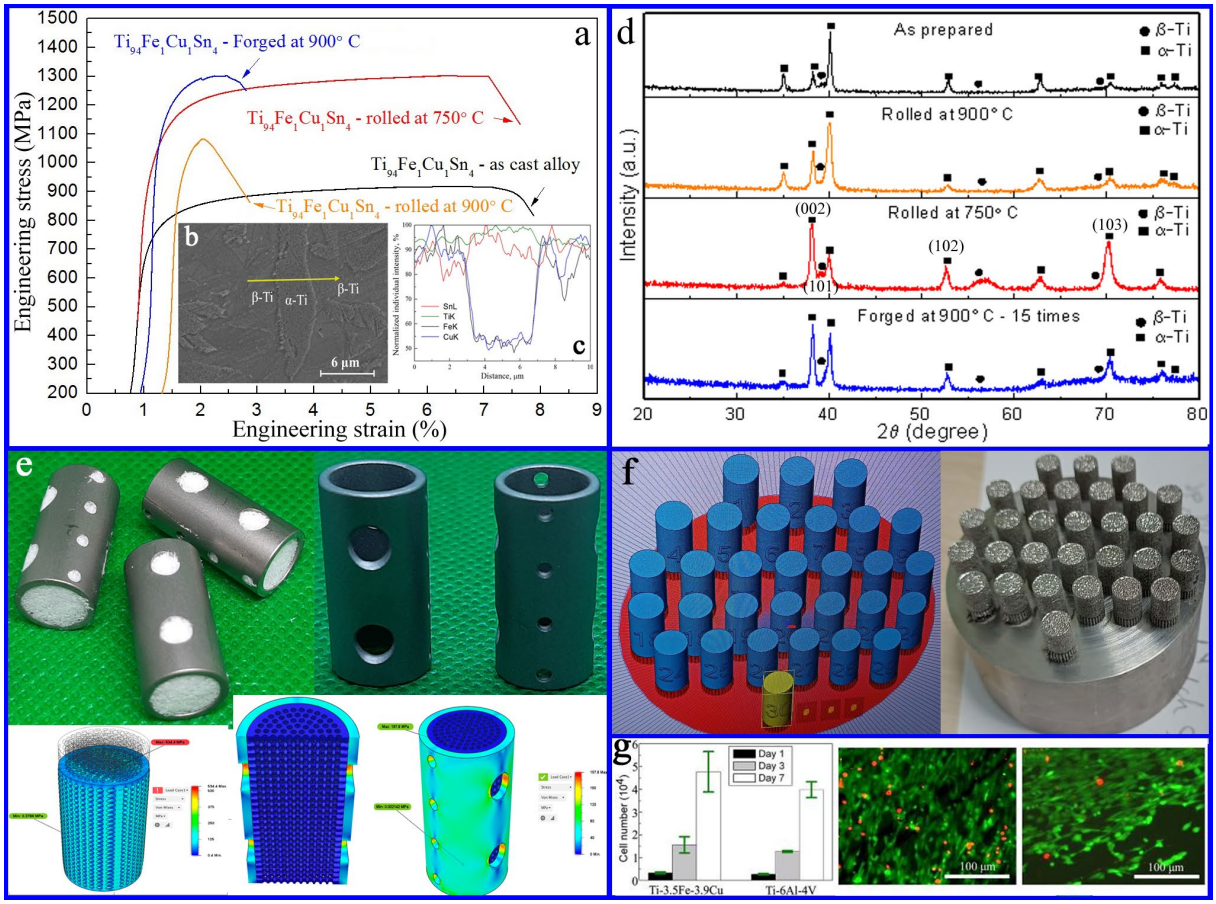

Fig.1 shows tensile mechanical properties of all the investigated samples (a), SEM (b) and EDX (c) analyses of the as-cast $Ti_{94}Fe_1Cu_1Sn_4$ alloy sample, XRD analyses of the $Ti_{94}Fe_1Cu_1Sn_4$ alloy samples in the as-cast state, rolled at 900 °C, rolled at 750 °C, forged at 900 °C for 15 times with sample rotation along the long axis (d), composite tube samples with and without biocompatible polymer (e), 3 D printed samples from the $Ti_{94}Fe_1Cu_1Sn_4$ alloy powder (f) and Cell proliferation and viability on the surface of titanium alloy (g).

Another part of the work was concerned to the biodegradable amorphous alloys. In this regard, the magnesium based metallic glass/PCL composite was fabricated by mechanical alloying method with subsequent co-extrusion process (Fig. 2, a). The co-extrusion process was provided in the supercooled liquid temperature region of the metallic glass and viscous region of the polymer. The metallic glass and PCL content, in the composites, was relatively stable and confirmed by XRD analyses. The composite possesses good thermal properties whereas the tensile test indicates the ability of composites to withstand deformation. In vivo studies states that the composites are biologically compatible and can be a promising biomaterial for maxillofacial surgery. In frame of this investigation area 2 research papers, with the acknowledgement of the research project, including investigation of amorphous/crystalline composites alloys were also published [3, 4].

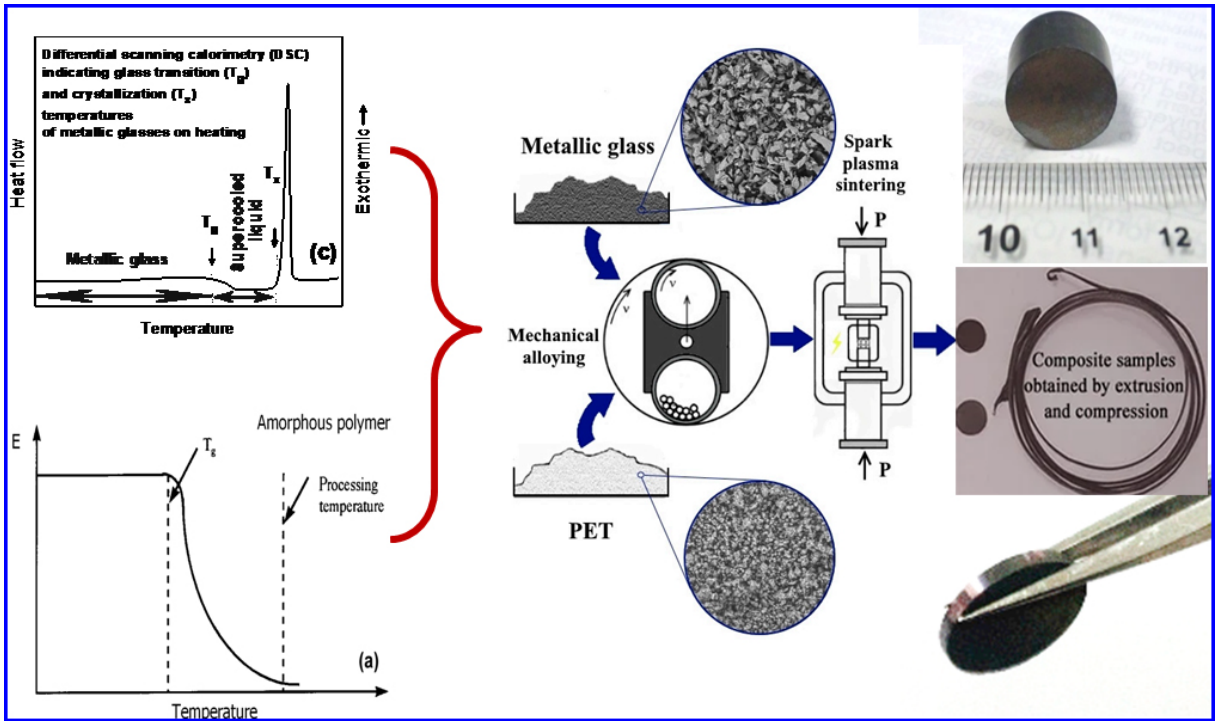

Fig.1 shows ehe scheme for obtaining bulk composite materials based on metallic glass and polymer during consolidation in the supercooled liquid temperature ranges.

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