Final Report

Project acronym: *Dressing4Scars*
Project number*: 4066*
M-ERA.NET Call 20*16*

Period covered: 01/09/2017 to 30/11/2020

Publishable project summary

The project proposes a 4D printing approach to deliver a new smart responsive scaffold to be used as a skin dressing. The goal is to obtain a dressing capable of changing "shape/mechanical cues" while new skin is being formed, counteracting pro-scarring mechanical forces. For proving the project concept, elastomeric materials (Poly (Glycerol Sebacate) (PGS) / Poly (Glycerol Sebacate) Acrylate (PGSA)) and gellan gum/ elastin-based hydrogels (GG/EL) were explored in parallel with a customized 3D printer. The materials and formulations were chosen based on the biomechanical requirements of the skin tissue and manufacturing requirements, respectively. Biomechanical requirements of the skin tissue were explored using healthy and cutaneous scar tissue. A database with the mechanical properties of human skin at multiple anatomical sites was created and then used for the customization of the skin dressing. In parallel, an *ex-vivo* human wound model undertaking mechanical stimulation was developed to assess the tissue response under injury. Simultaneously, hardware and software of the 3D printing process have been developed based on the specifications of the materials to be printed.

PGS properties were tailored by using different molar ratios of glycerol and sebacic acid. Then, the harsh processing conditions of PGS were overcome with the acrylation of PGS (PGSA) meeting the manufacturing requirements. Different PGSA and GG/EL based ink's formulations were prepared and redefined and readjusted to guarantee compatibility with the developed printer. 3D constructs/scaffolds with different pore sizes were successfully designed using different codes created by python (the programming software that allows the generation of a code of instructions for the 3D printer). As the elasticity and temporal evolution are directly related to the internal 3D structure geometry, the scaffolds were produced layer-by-layer deposition using different infill densities and patterns. Different printing parameters including printing temperature, printing speed, layer height, etc. were tested and the best conditions for printability of the different inks were selected. Final 3D structures were characterized in terms of physical properties and cytotoxicity.

Overall, the main results achieved in the project are: - a database on skin biomechanics under health and injured state; - a new customized 3D printer that can be then used with other materials with similar specificities as the ones developed in the project; - a set of ink formulations that can be tailored to perform programmed functions by simply varying material properties, geometry and composition.