P11

Microcontact printing technique with femto laser ablated stamps to induce cells alignment

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Abstract

Soft robotics is a particular branch of robotic, that uses soft and deformable material, like polymer, to create robotic devices. A new type of soft actuator that is emerging nowadays is bio-hybrid actuators. These devices combined a soft and biocompatible scaffold with an active biological part responsible for the motion (flagella, bacteria, or muscle cells). An interesting category of bio-hybrid actuators is based on muscle cells that are characterize, when organized in a tissue, by peculiar and performant actuation properties (high power/weight ratio, high motion control, high efficient energy storage and self-repair capability) especially if they are compared with other types of actuator, i.e. pneumatic actuation, electrochemical actuation. [1] The tissue-like organization is obtained exploiting tissue engineering strategy, in fact the better is the mimicking of the native properties of the muscular tissue, the better is the performance of the actuator. This structural organization can be achieved creating microgrooves on the surface [2], [3] as well as patterning adhesion proteins (printing facility [4] or microcontact printing [5], [6]).

In this work we propose a flexible alignment method based on a femtosecond laser micromachining technique that skips the time-consuming steps of the soft lithography. This method is cheaper and faster than soft lithography. It is easy to obtain complex geometry changing the code of the laser movements and its parameters (power, repetition rate, scanning rate). Femto laser technique not only can create a pattern on surface of a material, but, thanks to its high versatility, it can shape the 3D structure of an object and create complex design.

We obtained a stamp that has a series of parallel line, characterised by an average width of 84.8±4.0 µm and a lines distances of 27.8±2.4 µm. Figure 1 show an example of these stamp, taken with Scanning Electron Micrscopy (SEM). The depth of the groove was higher than 60 µm. Those values are those reported to be optimal to induce skeletal muscle cells alignment [7].

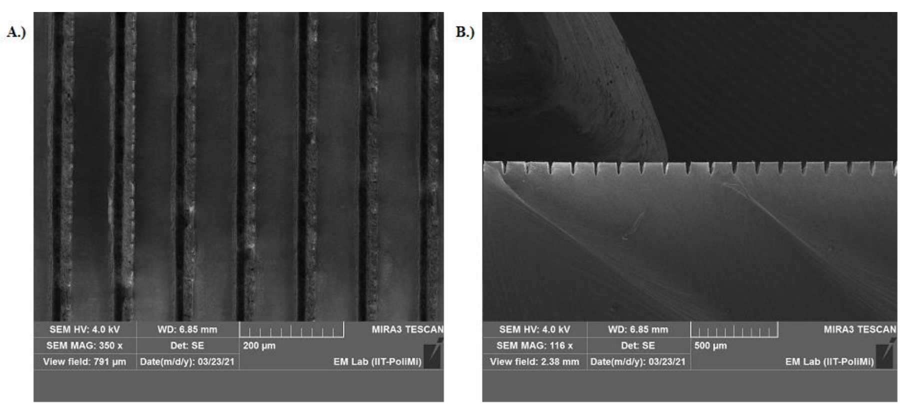

Fig. 1. A.) SEM image of planar view of a PDMS stamp. B.) SEM image of cross section of a PDMS stamp.

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P11

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