Summary of Project Results

FEASIBLE has settled the base for the next generation in femtosecond (fs) laser micromachining, demonstrating that with a hybrid approach it is possible to overcome the technology limits. Specifically this has been demonstrated through the fabrication of several bio-microchips with applications in cell manipulation experiments and biological sensing.
Combining fs laser irradiation followed by chemical etching and fs laser 3D printing we can fabricate glass microfluidic chips with different functionalities inside them. Not only, by the combination with other techniques like RF sputtering or electro-less metal plating we are capable of integrating optical filters or metal electrodes to further enrich the Bio-microchip.

Objectives and background of the project

The recent trend in the manufacturing industry is to replace expensive and time-consuming mechanical material processing by higher quality and faster alternatives. In this framework, photonic manufacturing is a key enabling technology that might give a competitive advantage over emerging economies that leverage low-cost labor. Fs laser micromachining is particularly interesting in high-profile applications because of its ability for minimal damage and precise processing. Moreover, in principle any materials, transparent or opaque, can be processed with the same fs laser system, thus enabling the manufacturing of innovative multi-material devices. 3D photonic manufacturing, based on fs-lasers, can be divided into two main categories: the subtractive one, where the machined material is removed from the original piece, and the additive one, where new structures are created (e.g. by photopolymerization) during the machining.
The goal of FEASIBLE project is to combine both categories in just one manufacturing process to fabricate advanced devices such as bio-microchips with unprecedented functionalities and with a single production tool.
This hybrid approach will solve the difficulties of performing bio-microchips combining 3D glass microfluidic networks with 3D polymer micro-components. This technology enables the direct fabrication of polymeric components inside the microfluidic networks for the on-chip integration of functionalities such as sensing and manipulation of bio and chemical materials. The devices developed in the project will find applications in different fields of biotechnology such as medical diagnostics, environmental monitoring, agriculture and food quality or protection against hazardous agents.

International cooperation

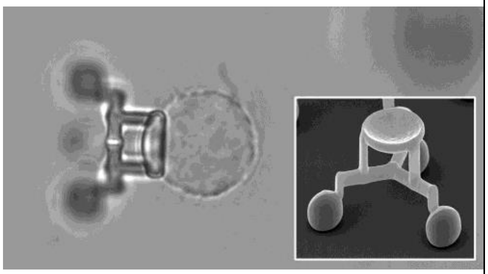
The FEASIBLE consortium is constituted by three world-widely recognized groups in the field of fs laser micromachining, which has been a strong point for the success of the project. Each research group directly involved two researchers in the project, one of whom was a young researcher with demonstrated research experience.

FEASIBLE project brought the opportunity to the three research groups of working together for the first time. There has been an active exchange of information and experience, which is translated in the birth of a strong scientific relationship.
This international cooperation provided the researchers the access to additional expertise, while working on complementary lines of efforts. The cooperation allowed us to arrive faster on our common scientific goals.

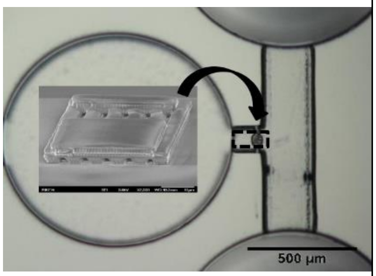
Output of interest to the public

Overall FEASIBLE has been a highly fruitful project with several scientific outputs based on international collaboration. Among them, we can select three that are the most representative of the developed technology.

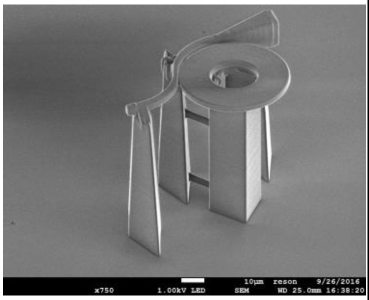
1. **3D printing of micro tools for cell manipulation.** We have fabricated 3D micro-sized tools capable of trapping biological cells by a protein-protein link. The tool which movement is controlled by laser beams, allows the manipulation of the cells without directly acting on them. This tool is an excellent example of the new generation of biological tools that microscopically helps in the analysis of biological samples.



2. **Bio-microchip for cancer cell motility studies**. A set of 3D printed micro- and nano-channels, mimicking human body small vessels are embedded inside a glass microfluidic chip. The cells cultured in the glass chambers are tempted, by an “attractive” chemical agent, to migrate through the 3D smaller channels. This mimicking of the in-vitro motility of metastatic cells will give a better comprehension of their behavior and help in the development of new cancer therapies.



3. **Integrated label free sensor for biological molecule detection.** A 3D printed optical microsensor is fabricated inside a microfluidic glass chip. The microsensor is a free standing optical microresonator that allows to detect biological specimens flowing in the glass channel without treating the flowing sample. This device is highly integrated and user friendly, in order to allow non optics expert to easily use it.



Links for more information

http://www.mi.ifn.cnr.it/research/fs-micromachining
http://www.riken.jp/en/research/labs/rap/extr_photonics/riken_siom/
http://www.brc.hu/biophys_optical_micromanipulation.php

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