Conical microstructures for guiding light in lab on chip devices

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Here we propose the use of the pyro-electric effect for the fabrication of biocompatible and biodegradable microneedles and the interferometric characterization of the light guided through these microstructures.
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1. Introduction

Optical microstructures are of very high interest for delivering and or guiding optical radiation. On the other side, biodegradable and biocompatible microneedles have been recently employed for manifold fabrication of biomedical devices and lab on chip platform focusing on more sustainable solutions for the final user. Beyond the replacement of conventional hypodermic syringes, already innovative in itself, the use of microneedles could open the route towards portable lab on chip devices where the same microneedle could be used for drug delivery and photodynamic therapy. In fact, functionalized microneedles could find application to guide therapies for the treatment of diabetes, cancerous lesions, antimicrobial treatment, skin surgery and, more in general, controlled drug delivery. One of the main advantage in the use of microneedle is the possibility of combining drug delivery approaches based on the use of functionalized biopolymers with high flexibility in the fabrication procedure. In particular, advances in needle fabrication are actually going on toward direct and low cost methods for shaping biopolymers that could focus the light thorough the needle tips. Recently, an innovative approach of inkjet printing[1] and electro-hydrodynamic spray[2] has been proposed for high resolution printing and patterning. In particular, the printed droplets in case of polymeric inks have been deeply characterized and used as micro-optical lenses[3]. The fabrication of micro-optical components in biocompatible material represents a new approach for integrated microfluidic chips. Moreover, great attention could be represented by conical microstructures of different dimension that could be used for guiding and delivery light. Here we propose for the first time the interferometric characterization of the light guided through a pyro-electrodrawn micro needle. The pyro-electrodrawing represented an alternative fast and mild temperature strategy to the stamp based techniques for the fabrication of poly(lactic-co-glycolic acid) (PLGA) needles. A point-like thermal stimulation of a ferroelectric crystal[4] or the use of titanium micro-heaters integrated onto the pyroelectric substrate[5], which is the electric field generator, enabled the electro-drawing of single or parallelized needles. The results reported show the possibility of controlling and guiding external light at specific points through the microstructures. The implantable systems have been characterized in terms of geometry, intensity and emitted light profile. We believe that these devices will improve the efficacy of existing phototherapies, such as blue light therapy for antimicrobial treatment and photodynamic therapy for cancerous lesions for in vivo and in vitro application.

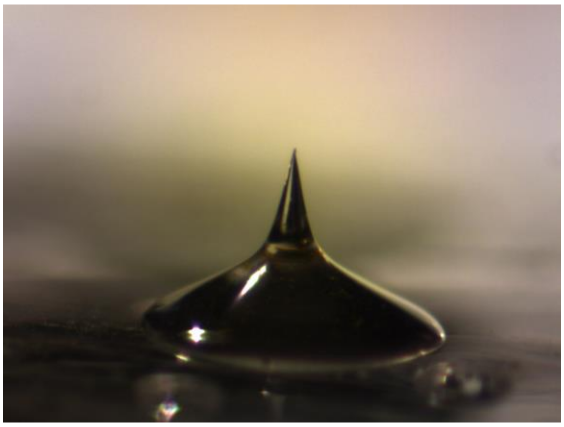

Fig. 1 Conical microstructures fabricated in PLGA using the pyro-electrodrawn technique. The same needle could be used at the same time for transdermal drug delivery and for guiding light.

References

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