**Polymeric SERS-fluidic platforms for the non-destructive optical analysis of liquid samples**

**Abstract.** The recent technological advances in micro- and nano-fabrication processes paved the way to the possibility to downsize optical detection techniques within microfluidic devices thus opening interesting perspectives towards the development of low-cost and portable (bio)sensors. These could be widely exploited for the optical analysis of liquid samples with potential applications in the clinic-diagnostic field, to precociously reveal pathological biomarkers in the biofluids as well as in the environmental and agrifood sectors to reveal contaminants [1]. Among all techniques, surface enhanced Raman spectroscopy (SERS) exploiting metal plasmonic gold nanoparticles (NPs) constitutes the one of the most promising analytical methods as alternative to current traditional bioassays [2]. Indeed, NPs with unique physical and chemical properties are exploited as high performing optical transducers that selectively capture and amplify (up to 10^6) the Raman signal scattered from analytes located near NPs with respect to the overall background matrices [3]. Despite all these advantages, SERS measurements guaranteeing picomolar sensitivity still rely on the exploitation of bulky confocal Raman set-up that cannot be used outside laboratories and leading to uncontrolled evaporation phenomena when tight focusing the excitation laser thus possibly inducing conformational changes of analyzed molecules [4]. To address these issues and to develop accurate portable systems, recent approaches are focused on synergically merge photonics and fluidics into miniaturized lab-on-a-chip (LoC) devices for light and fluids manipulation at the micrometric scale. Indeed, LoC technology enables easier handling of very small liquid volumes avoiding cross-contamination, efficient NPs-sample mixing [5] and, more interestingly, LoCs channels can be exploited to host optical fibers and waveguides for straight light delivering and collection at the fluids level [6]. Here, novel SERS-fluidic devices for the straightforward analysis of liquids have been developed by implementing time- and cost-saving manufacturing processes of polymers. The exploitation of low-cost traditional manufacturing processes and laser-based 3D printing guarantees high design versatility and smart interfacing with compact fiber-based Raman set-ups. To this end, the devices are constituted by network of channels for fluid handling and for optical fiber housing with embedded microfeatures used to control their relative positioning and to guarantee the highest signal delivering and collection. Within the detection chambers, SERS functionality is achieved by the selective interaction of the target analytes with gold NPs of varied size and shape attached to the bottom of the channel or pre-mixed with the samples. The resulting SERS-fluidic devices represent highly versatile sensing platforms providing high repeatability, high sensitivity and speed of analysis, possibly revolutionizing liquid analysis by making it costless, on-chip, handy, and easy to use.

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