Near field campanile probe fabricated by nanoimprint lithography

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Near-field scanning optical microscopy (NSOM) is a powerful and unique approach to characterize the chemical, physical and biochemical properties of materials with the nanometer scale resolution in real-time [1]. One of the main challenges in using NSOM for a broad range of applications is the development of reproducible and efficient near-field probes. A novel class of nano-optical probes has been recently proposed, namely "campanile". Campanile tips consist of a 3-Dimensional (3D) tapered structure terminated by a plasmonic nano-antenna, which provides superior NSOM performance and decisive advantages [2]. Fabrication of these probes is currently done by individually milling a Campanile structure on the facet of an optical fiber using focused ion beam (FIB). This fabrication process is highly time-consuming and expensive, and not suitable for a large-scale production. There is a direct need to simplify the manufacturing of these tips, and make them available to the end-users.

Here, we present a novel approach to drastically simplify the fabrication of Campanile probes by ultraviolet nanoimprint lithography (UV-NIL) directly on the facet of commercial optical fibers, without the need to use FIB (Fig. 1). The 3D mold is fabricated by a combination of polymer embossing and grey scale lithography in a Helium Ion Beam. Fabrication of Campanile probes by NIL is performed in a home-built imprinter. Alignment between the fiber core and the campanile mold is accurately achieved by optical means, and the UV-resist is cured by blue laser light coupled into the imprinted fiber. A metal coating is deposited on two sides of the pyramid, and a 'nano-gap' is naturally obtained at the apex of the pyramid, eliminating the need for an additional milling step by FIB. Preliminary results from near field scans using an imprinted probe show signs of sub-diffraction size features indicating the presence of field localization at the tip of the campanile. This work paves the way for low cost and reproducible manufacturing of near field probes suitable for high resolution hyperspectral imaging.

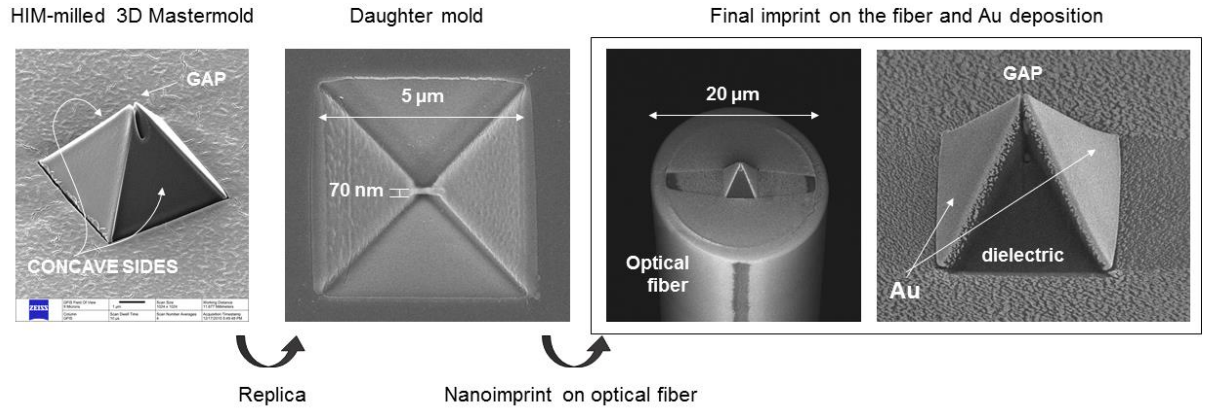

Figure 1 - Fabrication of a campanile NSOM probe by NIL on an optical fiber

References:

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