New active probe for scanning near field optical microscopy

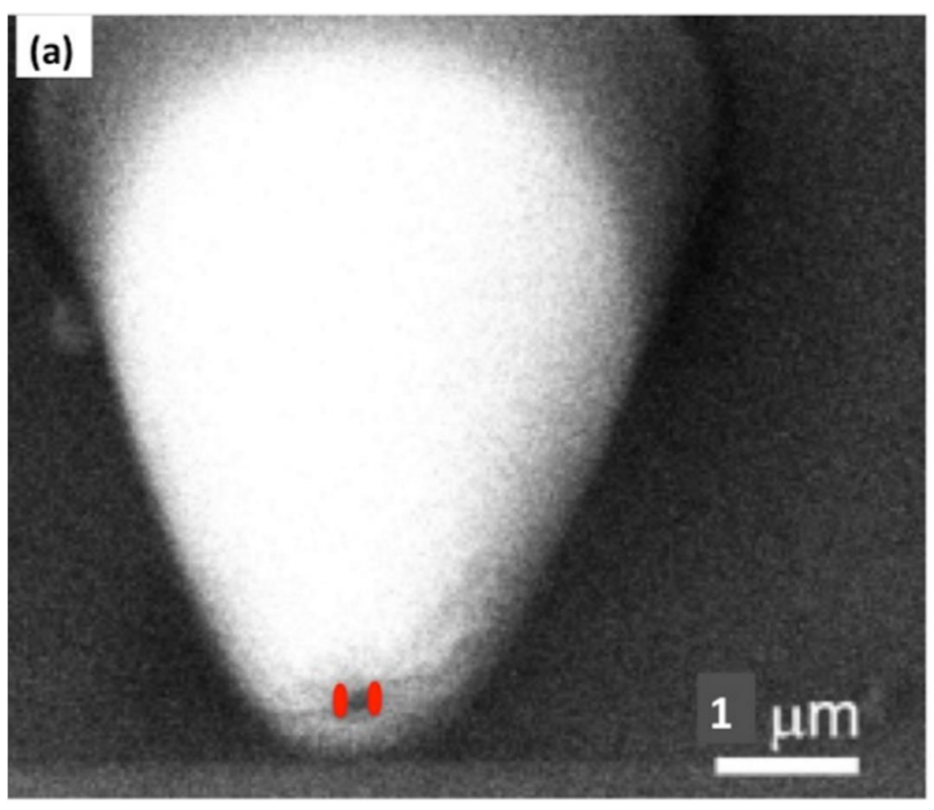
Hongshi CHEN[1], Regis Deturche[1], Jean Louis Bijeon[1], Jérôme Plain[1], Olivier Soppera[2], Celine Fiorini[3], Brahim Dahmani[4], Vincent Parat[4] and Renaud Bachelot[1]

[1] LNIO, Institut Charles Delaunay, CNRS UMR 6281, Université de Technologie de Troyes
[2] Institut de Sciences des Matériaux de Mulhouse, CNRS UMR 7361
[3] CEA Saclay
[4] Lovalite^{TM}, Ecole-Valentin
hongshi.chen@utt.fr, renaud.bachelot@utt.fr

Introduction: By collecting near field optical signal, SNOM is able to break the diffraction limit. In this sense, probe plays a crucial role. We aim at developing a new generation of SNOM probe, having active molecules on its extremity. With such active molecules, near field signal can be generated by the probe itself at a wavelength that is different from the incident one, permitting a decrease of the far-field background. Near field information can be collected when interaction between probe and sample near field happens. Reciprocally, active probe could be used as a local photonic source for other research purpose, like triggering photochemical reactions.

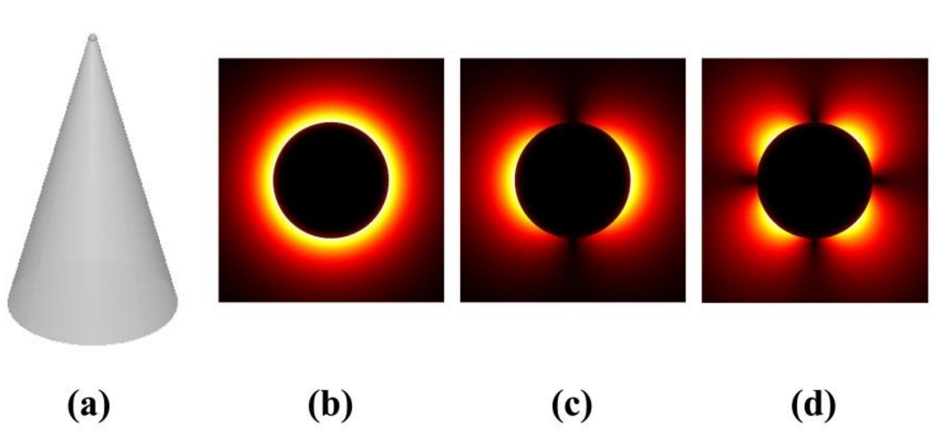
Objectives: Currently we try to integrate nano quantum emitters on metal coated fibered-aperture SNOM probes . Tapered fiber tip and polymer tips are both considered. The main strategy is to trap fluorescence light emitters around the nanoaperture by nanoscale photo-polymerization triggered by the aperture near-field energy. The process will be precisely controlled, in order to fabricate different kinds of active probe for different needs. Also, several emitters will be tested, from organic dye to QDs.

Active SNOM probe: principles



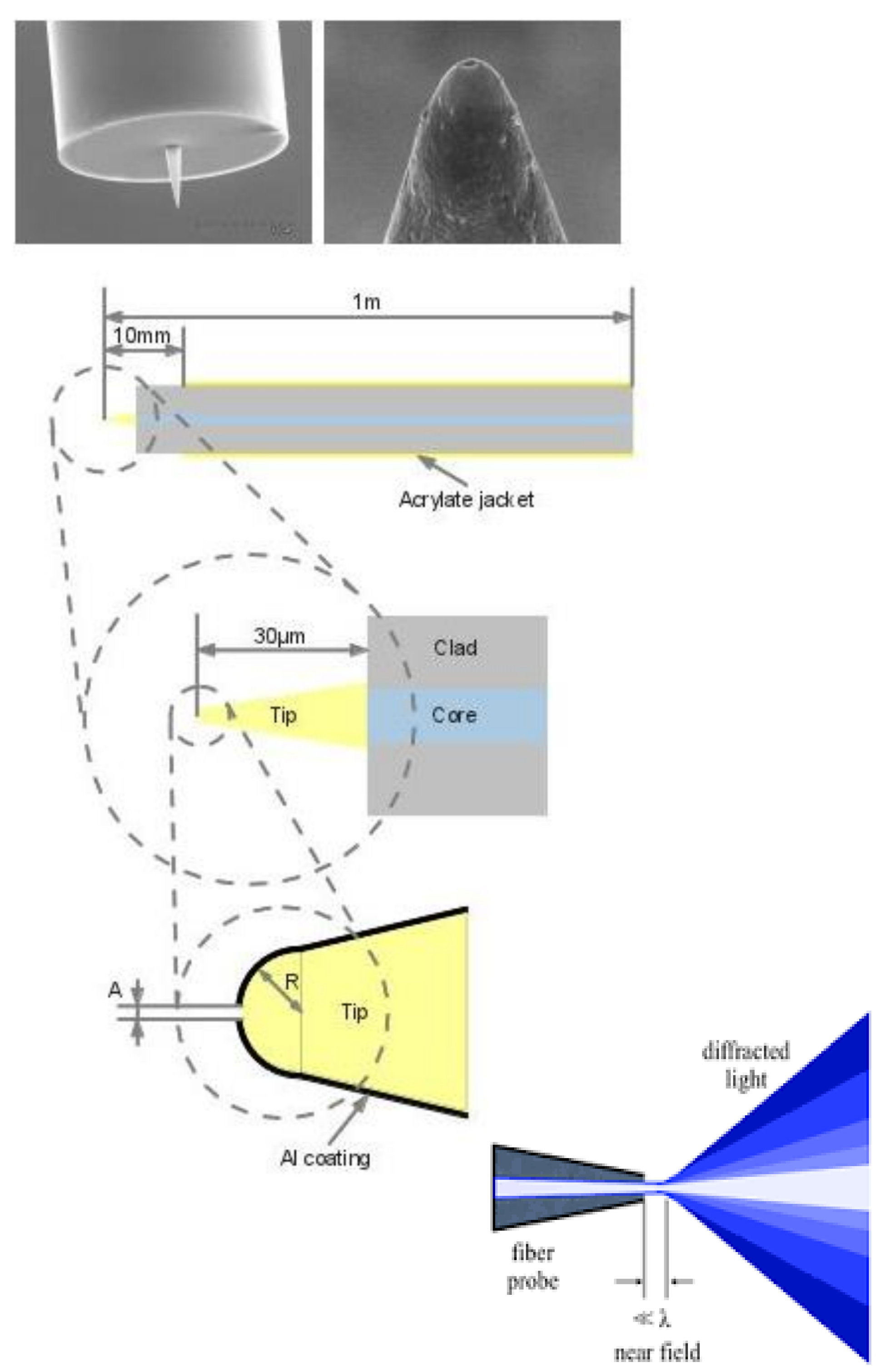
aperture probe with active area containing emitters (represented in red) that are integrated at its extremity, in the near vicinity of the aperture

Typical spatial distribution of optical near-field at the nanoaperture



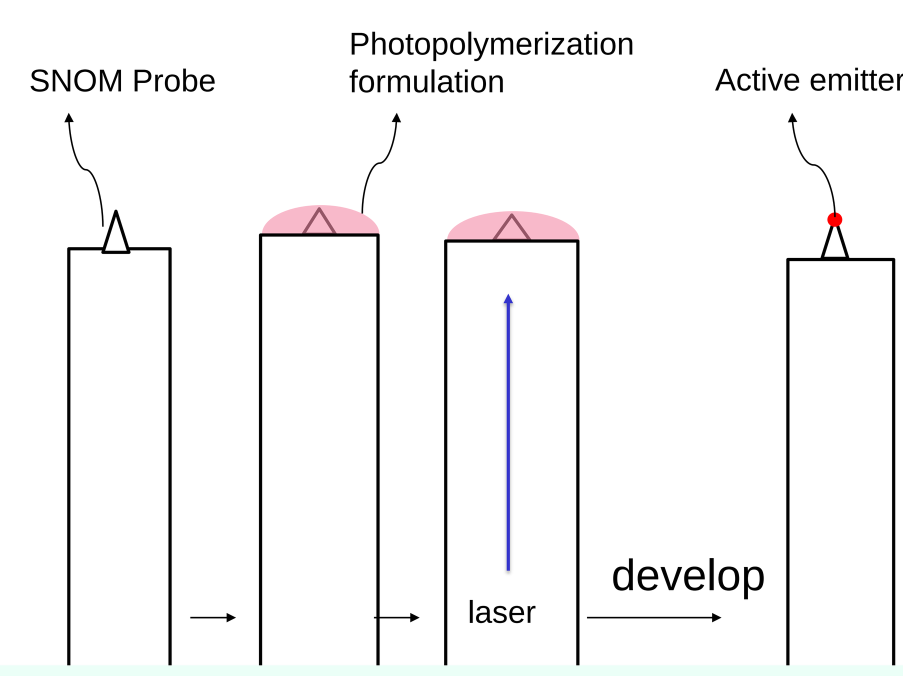
This field can be used either for nanoscale photo polymerization at the extremity or for exciting integrated nanoemitters.

Metal coating aperture SNOM probe

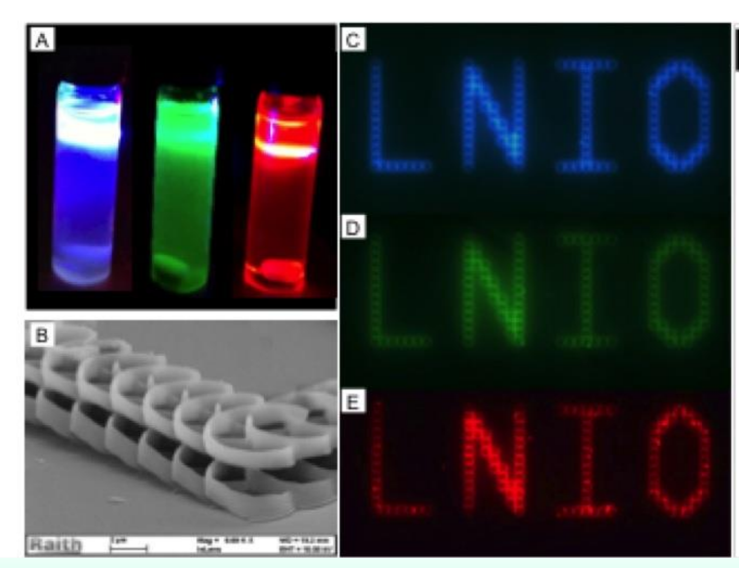


We will begin with commercial SNOM probes provided by Lovalite. Metal aperture permits near field confinement at probe extremity

Nanofabrication of active SNOM probe

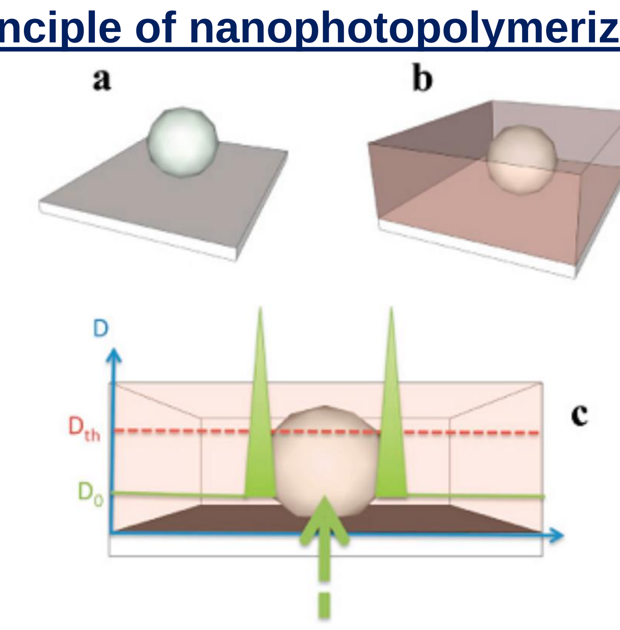


Precisely controlled exposure: exposure process could directly influence distribution of emitter at probe



Light emitting QD-containing photopolymers

Principle of nanophotopolymerization



Nanostructure(a) presenting a designed near-field covered by a photopolymerizable formulation(b) and laser illuminated resulting in polymer bulk corresponding to the distribution of the near-field intensity (c)

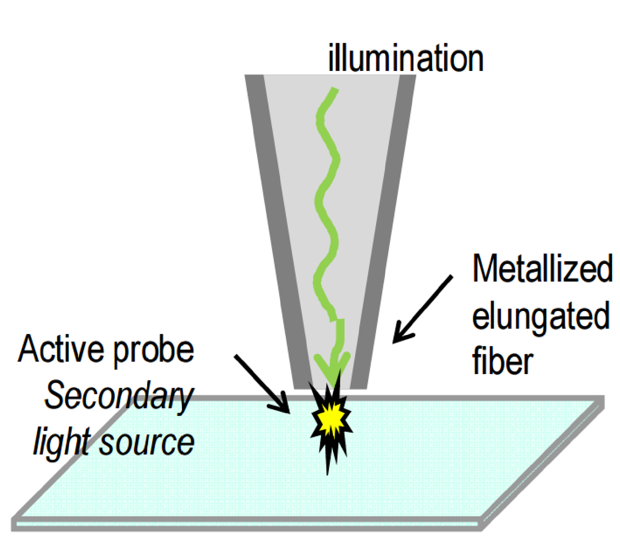
Photopolymerization Mechanism

Initiation : $S \rightarrow S^{*} \cdots \rightarrow I^{*} \rightarrow R^{\cdot}$

Propagation: $R^{\cdot} + M \rightarrow RM^{\cdot} \cdots \rightarrow RM_n^{\cdot}$

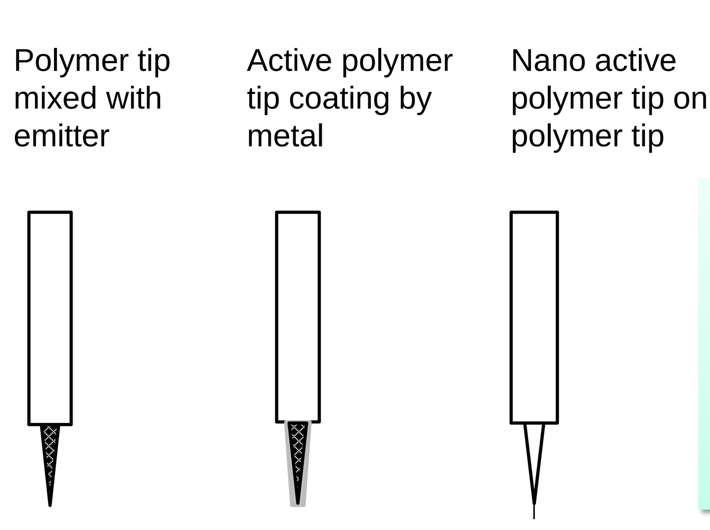
Termination: $RM_n^{\cdot} + RM_m^{\cdot} \rightarrow RM_{m+n}R$

Application and further study



Addressable near field emitter and local light source

Active probe with different configurations



Different configurations lead to different near field properties, to address various research cases

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