Thesis title: s-SNOM vibrational modes at high harmonics for sub-surface imaging in visible

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SNOM or Scanning Near-field Optical Microscopy [1] is an imaging technique with nanometric resolution and allowing access to the local opto-geometric properties of the observed sample. This technique, based on near-field interactions between a nanometer probe and the sample, is available in different modes. For example, scattering-SNOM uses the elastic light scattered by the tip to locally probe the optical properties of a sample [2]. In this configuration, the optical resolution is limited only by the radius of the tip curvature, generally between 10 and 20 nm, and no longer depends on the wavelength of the probing light. Thus, this technique has been proven in studies of chemical and structural properties. In addition, the use of a microcantilever as s-SNOM tip has allowed demonstrating the capability of probing the sample at various depths when using the different vibrational modes of the tip. However, if the spectral response is explained by the near-field dipolar interaction of the tip-sample system, the sub-surface near-field mode remains complex and difficult to implement especially when working in the visible range. Indeed, work have been done in the infra-red region

In parallel, the design and manufacturing of optical thin film stacks is the basis of many optical components allowing the realization of different optical functions (filters, mirrors, amplification...). The expected global optical response is controllable as well as the distribution of the electromagnetic field in all layers constituting the stack. The reproducible, stable, uniform and calibrated condition of these stacks offer a unique opportunity to quantify the probed depth for s-SNOM sub-surface imaging [3-5].

We therefore propose to use such optical thin film stacks whose thickness and optical index are well defined and controllable as a model object in studying depth versus vibrational modes of the s-SNOM tip. It will thus be possible to decouple volume effects from surface effects measured in s-SNOM for a better interpretation of the resulting maps. The expected depths measured by such a microscope are of the order of a few hundred nanometers in the IR spectral range [3].

We are looking for an excellent candidate with a strong background and interest in optics (nanophotonics, far and nearfield optical microscopy, optical components) and with a commitment for experimental developments and technological challenges.

References

[1] *Lereu et al, Int. J. Nanotechnol. 8 (2012)*
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[4] *Krutokhvostov et al, OE 20, 593 (2012)*
[5] *Mester et al, Nature Comm. 11, 3359 (2021)*