Fabrication of clamped-clamped microbeams with embedded nanochannels towards nanoparticles sensing

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1. Introduction

Nanoparticles play a big role in nanotechnology field thanks to their widespread applications, from medicine to environment remediation. Moreover, are present also in our «normal life» as in the solar protection, in the toothpaste and in several other products. Because of this spread in use, more and more tools for a precise characterization are required. The actual methods allow for a precise characterization of nanoparticles dimensions and size distribution. However, they also require very expensive instrumentation and time-consuming sample preparation. Suspended micro- and nanochannel resonator (SMR)[1] represent the best approach in terms of costs and easy sample preparation to identify localized masses such as single nanoparticle: in fact, the coupling of a nanofluidic channel with a mechanical resonator offer the possibility to characterize samples directly in liquid with the very high intrinsic resolution of the clamped-clamped beam resonator.

2. Fabrication and characterization

The fabrication process exploited for this kind of devices is very easy and flexible: it allows to produce resonators both with nanoslits (in which the nanometer dimension of the hollow channel is only the height) both with nanochannels (that has both the height and width at the nano-dimension). The process is based on a sacrificial layer approach: a 50 nm thick silicon layer is first deposited and structured by dry-etching techniques and then it is removed using the Xenon Difluoride to create a hollow channel buried in the silicon dioxide. The choice to use only dry process in due to avoid as much as possible problem of stiction during the releasing steps.

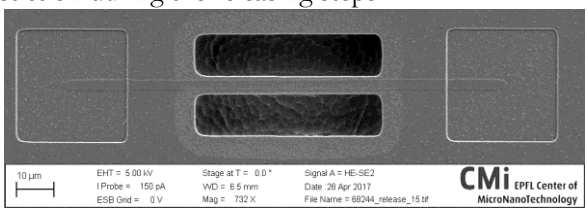

Figure 1: Microbeam with nanoslit channel (length 80 um, width 5um, height 50 nm)

After the fabrication part, preliminary characterizations of the mechanical proprieties of the clamped-clamped beam and fluidics one of the nanochannel have been already done giving promising results on the achievable sensitivity of the resonating sensor: between 200-300 ag/Hz with the nanoslit devices and around 20 ag/Hz with the nanochannel based ones.

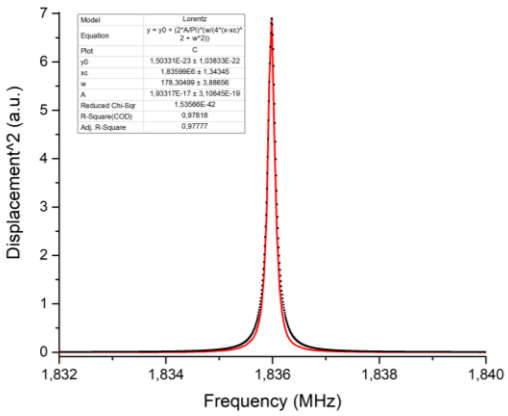

Figure 2: Mechanical Characterization in vacuum: the Lorentzian fit of the first mode peak. A Q factor of about 10.000 has been measured.

References

[1] Burg, Thomas P., and Scott R. Manalis. "Suspended microchannel resonators for biomolecular detection." Applied Physics Letters 83.13 (2003): 2698-2700.