Functionalized patterned sensors on top of optical fibers

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Motivations

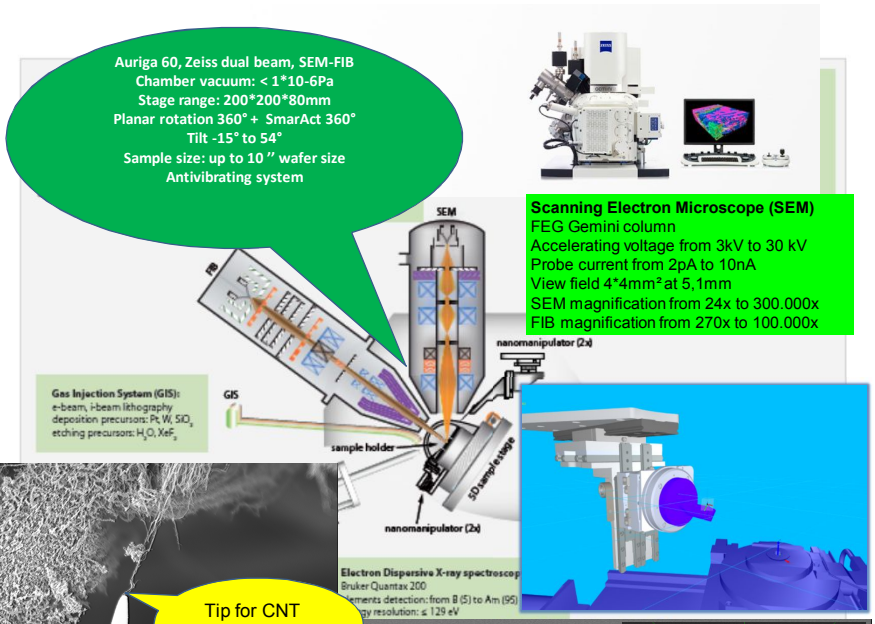
The aim of this study is to present the **new generation of micro and nano factories** under vacuum in order to produce **new generations of sensors** by functionalizing, patterning, assembling with very high accuracy micro **materials on top of metallic tips, or optical tips/fibers**. Our nano factory called **µRoboteX** station consists of a **Zeiss Auriga 60 dual beams SEM/FIB**, in which we have added a **GIS** (Gas Injection System) and **two micro robotic arms**, Kleindiek and Smaract. By this way, with the 5DoF sample holder of the SEM, **we have three 'hands'** in the chamber, totaling **14 DoF**, and we are able to **pattern, etch, cut, fold, assemble and weld several materials,** especially bio-sensors, chemical sensors and nano-photonic sensors, in real 3D structures.

Operating conditions

- Auriga 60 from Zeiss with dual MEB/FIB beams,
-Sample holder stage 5dof: X, Y, Z, Z' for **eucentric point,** Θ and SmarAct Θ' ,

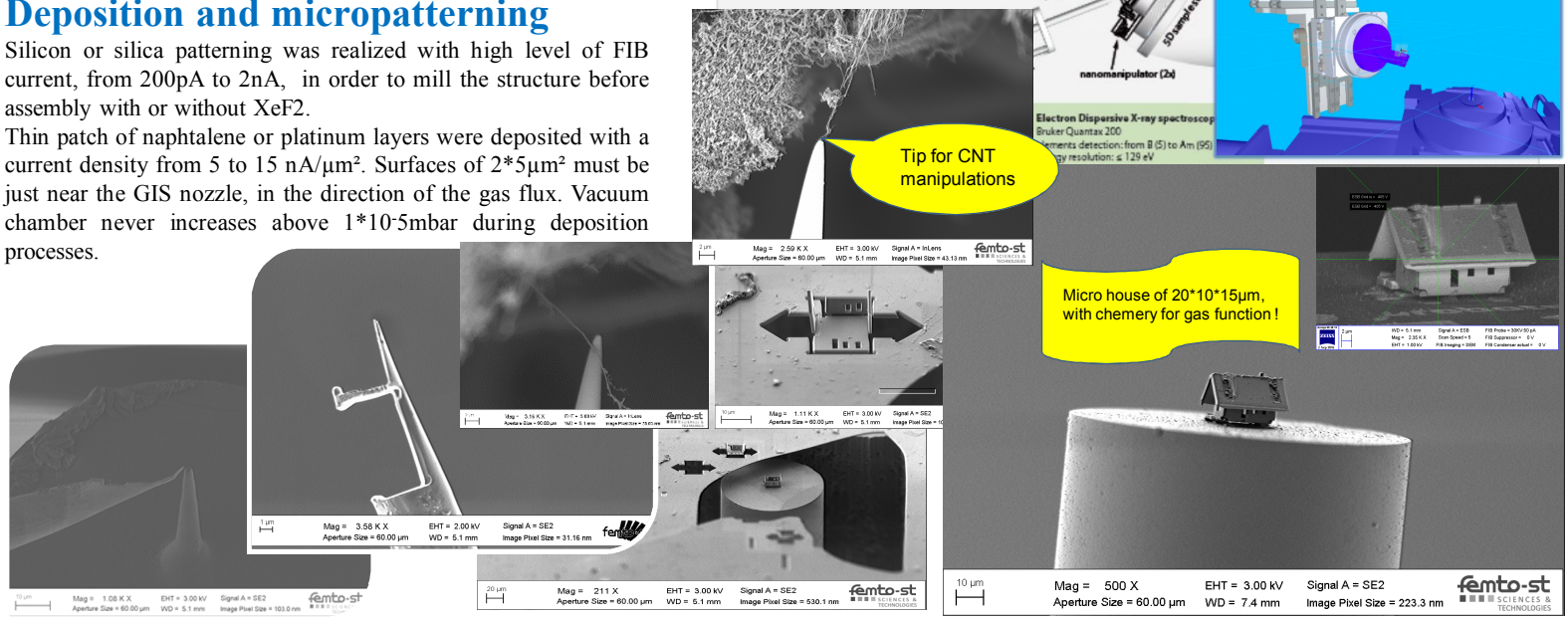
- **SmarAct** micro robot with 6DoF X*Y*Z:150*70*70mm±20nm, Θy: Θz : 7°±0,001°, , Θx (tools) 360°±0,001°

- Gas Injection System with: **XeF2** for etching and patterning materials and sensors, **W**(CO)6, Cyclopentadienyl **Pt**, for CVD thin layer or thin nano printing,
- Kleindick tip with 3DoF,
- Working space of **0,5mm3** for assembly the microstructures, and the micro-sensors…
- Inlens, EBSD and SE2



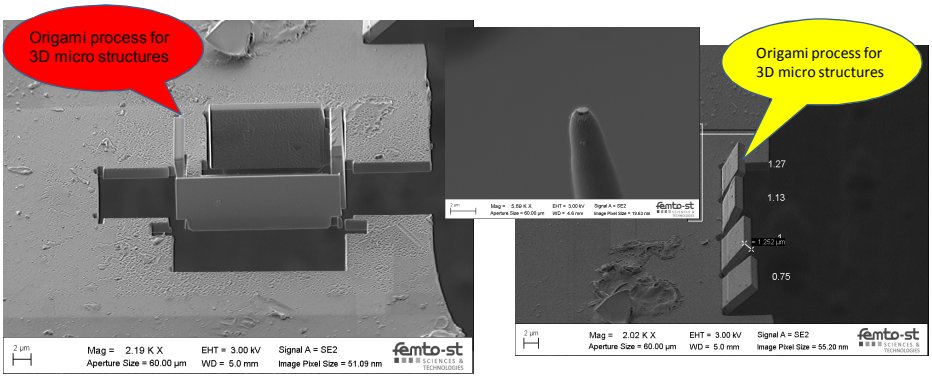
Deposition and micropatterning

Silicon or silica patterning was realized with high level of FIB current, from 200pA to 2nA, in order to mill the structure before assembly with or without XeF2.
Thin patch of naphtalene or platinum layers were deposited with a current density from 5 to 15 nA/µm². Surfaces of 2*5µm² must be just near the GIS nozzle, in the direction of the gas flux. Vacuum chamber never increases above 1*10-5mbar during deposition processes.



Microstructures assembly and Origami

Thin silicon/silica patterned boxes microstructures were assemblied with the SEM's stage and µrobot on top of cleaved optical fibers. The set attachment was made with naphtalene and gallium beam by the way of IBAD layers during several processes. The surfaces of sensors were prepared in clean room and pattern by lithography or FIB. Origami is used in order to realized 3D structures before installing the structures on top of cleaved optical fiber for optical interrogations, gas sensors or nano photonics sensors. The microscopic house on top of optical fiber was realize in order to summarize all the ability of the **µRoboteX** station.



Conclusion

Important projects are on the way on **µRoboteX** station, especially in **optical and micro-robotic fields**, in order to assembly thin optical sensors on top of optical fiber by the control of optical loss. This new technical facilities enlarge the scope of clean room processes and open the way for micro and nano assembly in the new generation of nanofactories. By this way, we can produce new generations of opto, bio, chemical, mechanical or gas sensors,

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