





REGION BOURGOGNE FRANCHE COMTE





## Functionalized patterned sensors on top of optical fibers

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## **Motivations**

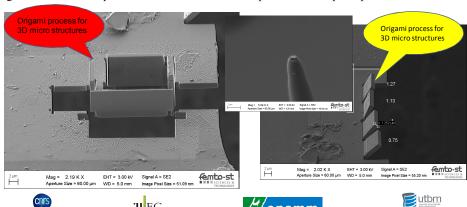
The aim of this study is to present the new generation of micro and nano factories under vacuum in order to produce new generations of sensors by functionalizing, patterning, assembling with very high accuracy micro materials on top of metallic tips, or optical tips/fibers. Our nano factory called **µRoboteX** 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.

<ul> <li>Operating conditions</li> <li>- Auriga 60 from Zeiss with dual MEB/FIB beams,</li> <li>- Sample holder stage 5dof: X, Y, Z, Z' for eucentric point, Θ and SmarAct Θ',</li> <li>- SmarAct micro robot with 6DoF - X*Y*Z:150*70*70mm±20nm,</li> </ul>	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	Auriga 60, Zeiss dual beam, SEM-I- Chamber vacuum: < 1*10-6Pa Stage range: 200*200*80mm Planar rotation 360* + SmarAct 36 Tilt -15* to 54* Sample size: up to 10 " wafer siz Antivibrating system	50°	FEG Gemir Acceleratin Probe curre View field 4 SEM magn	Electron Microscopni column g voltage from 3kV to ent from 2pA to 10nA *4mm <sup>2</sup> at 5,1mm ification from 24x to 3 ication from 270x to 1	9 30 KV 800.000x
Θy: Θz : 7°±0,001°, , Θx (tools) 360°±0,001° -	Inlens, EBSD and SE2	Gas Injection System (GIS): e-beam, Heam Ikhography deposition precursors: PL(0, XeF, etching precursors: PL(0, XeF,	unple holder			
<b>Deposition and microp</b> Silicon or silica patterning was realiz current, from 200pA to 2nA, in order assembly with or without XeF2. Thin patch of naphtalene or platinum la	ted with high level of FIB to mill the structure before ayers were deposited with a	Tip for CNT	nanomeripulator (24) Electron Dispersive X-ray spectro Bruker Quanta: 200 Parents detection: from 8 (5) to Am parent detection: from 8 (5) to Am	scop		
current density from 5 to 15 nA/µm <sup>2</sup> . S just near the GIS nozzle, in the directi chamber never increases above 1*10 processes.	on of the gas flux. Vacuum	Nays 255.KX New Work 200 /m NC - 51.700 Pay Particles 4.5120 Participants	Micro house of 20*		The set	1
Ling a 33 K Aprilia Bian 6	Mar Stress Office and A SE2 X Brit - 200W Signal A SE2 Mar Stress Stre	Martin art State	with chemery for g			Hana Holigi Hina Hana Holigi Hangara Lu Hangara Hangar
Mag =         1.08 K.X         EHT = 3.08 K/         Signal A= 562         Ambo = 51           Apenue Sce = 60.00 µm         W0 = 5.1 mm         mage Plast Sce = 100.0 mm         4 = 1.8 mm/s/s/s/s/s/s/s/s/s/s/s/s/s/s/s/s/s/s/	20 µm Mag = 211 X EHT = 3.00 K Aperture Size = 60.00 µm WD = 5.1 mm		Mag = 500 X Aperture Size = 60.00 μm		Signal A = SE2 Image Pixel Size = 223.3 nm	SCIENCES & TECHNOLOGIES

## **Microstructures assembly and Origami**

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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.



<u>//ensmm</u>

## 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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