ORIGAMI BASED MICRO-ROBOTICS FOR NANO-MANIPULATION IN SEM

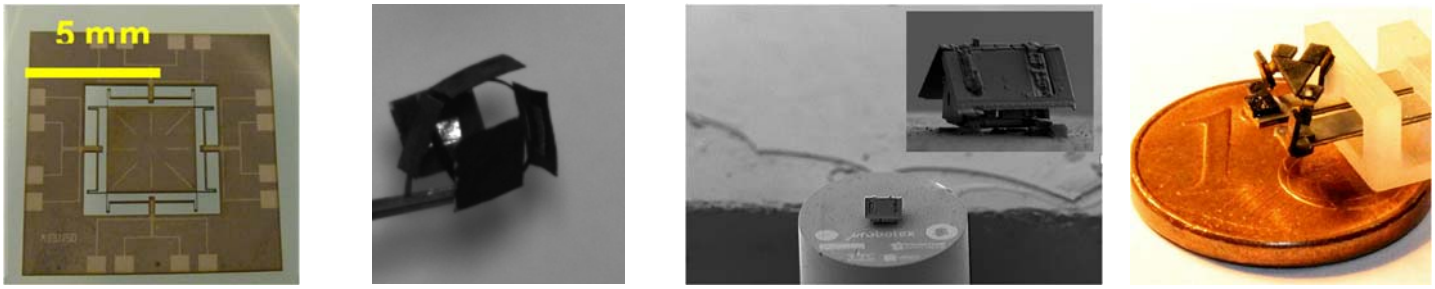
Proposed job-position
Duration: 12 months contract (renewable), must be starting in 2018
Salary: depending on the experience
PhD are targeted applicants, engineers are also welcome

Context of the works
Nanoscience and nanotechnology are fastly growing and today enables the manufacturing of a wide variety of nanocomponents with exceptional properties. There are now pressing needs for technologies able to manufacture the next generation of high added value nanodevices and for "smarter, cleaner and intelligent" process technologies. Nevertheless, currently used manufacturing processes are facing intrinsic limitation due to tremendous lack of flexibility and adaptability. Alternatively, state of the art works investigated an approach that is disruptive at this scale, consisting in the manipulation and assembly of single components such as nanotubes and nanolamellas using tweezers or tips [1]. Notable proof-of-concept achievements demonstrate the potential of this approach opening a broad avenue to a new generation of highly compact devices [2]. However, tools used for manipulation and assembly have been derived from instrumentation ones and enable sufficient performances for a few dedicated tasks only.

Objective of the works
To break this barrier, proposed works aims at establishing the ground-breaking basis for the next nanorobotics generation targeting disruptive nano-robot abilities through using origami based micro-robots for nanoscale manipulation. It will notably deeply address the paradigm of motion and manipulation abilities that has been extensively studied at the macroscale but which remains a fully opened scientific issue at the nanoscale due to many impacting specificities (predominance of surface forces such as van der Waals forces, varying behaviors, influence of environment…).

Works to be performed
Original nanorobotics architectures based on the continuous-deformation of smart structures combined with origami principle will notably be investigated. The approach chosen will rely on two complementary smart matters: thick piezoelectric films that recently demonstrated exceptional performances for micro-robotic purposes [3] and conducting polymers [4]. This combination offer very high displacement ranges and high dynamics within very small volumes and for low applied voltage (*Fig. 1-a*). Complementarily, complex foldable structures have also been demonstrated recently [5]. *Fig. 1-b* notably highlights our capability to realize an origami-based principle house built at the tip of an optical fiber. This proposed principle enables very complex and 3D structures but that are passive.

The objective of the works will be to combine these two techniques such as obtained in *Fig. 1-c* and *Fig 1-d*, to propose original and novel 3D soft micro-robotic architectures that will be active and with very high performances. Works will notably consist in modelling of this novel kind of architectures in an analytical way, develop clean room fabrication processes to enable their fabrication and to develop experimental set-up to investigate their experimental behavior. The recruited colleague will be part of a team and then will have then several key collaborations especially for modelling and fabrication.



(a) (b) (c) (d)

Fig. 1: (a) 6 Degrees-of-Freedom parallel micro-robot fabricated by thick-piezoelectric films (b) cube origami actuated by conducting polymer [4], c) 20 µm side house built at the tip of an optical fiber based on origami approach fabricated on our Microrobotex[1] platform, and d) Smart composite microstructure and its resulting folded micromechanism [5].

Required qualifications

To address this topic, we are seeking for a young, talented, open-minded and enthusiastic colleague merging competencies in the mechatronics, microtechnologies and/or robotics fields. A strong sense for communication in a collaborative and multidisciplinary environment is expected as additional skills such as conducting experimentations, programming and simulating using Matlab or equivalent software.

Bibliography

[1] N. Pavliček et al. Generation, manipulation and characterization of molecules by atomic force microscopy. Nature Reviews Chemistry, 1, 0005 (2017).

[2] J. Liddle et al. "Nanomanufacturing: a perspective." ACS nano 10.3 (2016).

[3] A. Bienaimé et al. "Static/dynamic trade-off performance of PZT thick film micro-actuators." Journal of Micromechanics and Microengineering 25.7 (2015)

[4] A. Benouhiba, K. Rabenorosoa, M. Ouisse, and N. Andreff, Electro-active polymer based self-folding approach devoted to origami-inspired structures, ASME Smart Materials, Adaptive Structures and Intelligent Systems (SMASIS), San Antonio, Texas, USA, 2018

[5] S. Miyashita, et al. "Robotic metamorphosis by origami exoskeletons." Science Robotics (2017).

[6] S. Lescano, M. Rakotondrabe and N. Andreff, 'Precision Prediction Using Interval Exponential Mapping of a Parallel Kinematic Smart Composite Microstructure', IEEE/RSJ - IROS, (International Conference onIntelligent Robots and Systems), pp.1994-1999, Hamburg, Germany, Sept-Oct 2015

Information and applications

Send a unique PDF file to cclevy@femto-st.fr including a detailed CV, motivation letter dedicated to the job offer, mark and ranks of the two last years of studies.

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[1] The Microrobotex Platform is a powerful Scanning-Electron-Microscope that includes 14 DoF robots. This platform is part of the national network for platforms of excellence.