POLYARTICULATED, LIGHT-ACTIVATED STRUCTURES MADE FROM ORIGAMI OF SILICA MEMBRANES, INSTALLED AT THE END OF OPTICAL FIBRES.

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We propose a 3-dimensional micro-gripper made by complex assembly and machining of a 900nm thick silica membrane Fig 1 and 2 fabricated in the Mimento clean room. The micro-gripper, installed here next to a human hair, Fig2, is placed at the end of a stretched and metallized optical fibre and it is the light emitted by the stretched fibre that allows the actuation of the clamp whose joints and arms are made of silica. The technologies used are similar to those used for the micro house [1,2], but in this case, we add a third part coming from another wafer also produce in the Mimento Clean room. It is a silica membrane of 600nm coated with an optimized aluminum layer. The silica/aluminum bilayer is welding just at 1 µm of the point of the drawn optical fibre in a perpendicular way in order to bring the light which is converted into heat for the actuation of the bimetallic Al/SiO2. This micro thermal opto gripper is in the field of micro and nano robotic polyarticulated structure.

The micro gripper is made from a micro and nano origami of a 900nm silica membrane with a final step of a 600nm silica bimetal coated with 280nm aluminum to convert the heat from light into mechanical deformation.

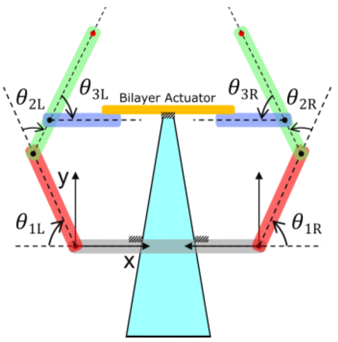

Fig 1: shematic vue of the micro gripper.

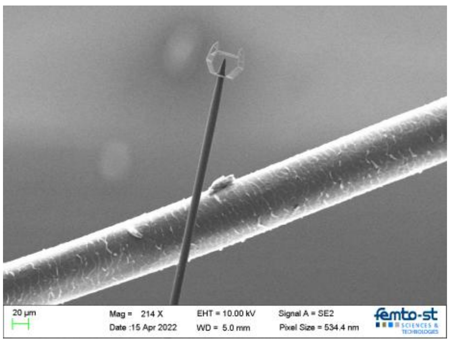

Fig 2: microgripper next to a human hair

Assembled at the end of a stretched optical fibre of the order of 4.5 µm in diameter at the tip, this micro-gripper operates with the light power diffused into the fibre core. Entirely realized using the µRobotex station in the CMNR platform, this demonstrator illustrates the capabilities of ultra-precise machining, fine positioning and micromanipulation of micro- and nanometric objects. In this particular case, the first part of the technological work consists in 'building the micro-gripper structure' from a plane silica membrane obtained by thermal oxidation of a silicon wafer. The silicon is removed by DRIE.

The second part of the work consists of preparing the tip of the fibre to strip the deposited chromium to ensure SEM and FIB observability of the fibre. In this case, the chromium layer of 50 nm is deposited on the drawn optical fibre in order to concentrate all the light intensity at the tip. It is also necessary to strip the chromium at the tip to allow the light to exit to ensure the heating of the aluminum/silica bimetal that will be used to heat the fibre.

The third part of this work corresponds to the embedding of the optical fibre with a tip diameter of 4.5 µm in a hole with a diameter of 8 µm in order to definitively weld the base of the micro gripper perpendicularly to the end of the optical fibre. The soldering is carried out here using a naphthalene CVD deposition crown according to a beam steering method that has just been installed on our µRobotex station according to an internal development.

The fourth part of this very complex robotic assembly, corresponds to the installation of a panel of aluminum coated silica, corresponding to a bimetal, coming from another wafer specially developed to obtain a thickness ratio of 0.45 between the aluminum thickness and the silica thickness allowing to obtain the maximum deformation of the bimetal. This 30*10µm*0.88µm panel is installed perpendicular to the fibre and to the direction of light propagation. This panel is welded between the two smaller panels using the same CVD naphthalene deposit as used for the base of the micro gripper on the tip of the optical fibre. All the system is carried by the fibre, which is the actuator and and the holder.

[1] Smallest micro house in the world, assembled on the facet of an optical fiber by origami and welded in the µRobotex nano-factory," is authored by Jean-Yves J. Rauch, Olivier Lehmann, Patrick Rougeot, Joel Abadie, Joel Agnus and Miguel Angel Suarez. *Journal of Vacuum Science & Technology A: Vacuum, Surfaces, and Films* 2018 (DOI: 10.1063/1.5020128).http://aip.scitation.org/doi/full/10.1063/1.5020128.

[2] Lei, Y., Clevy, C., Rauch, J., & Lutz, P. (2022). Large-Workspace Polyarticulated Micro-Structures Based-On Folded Silica for Tethered Nanorobotics. IEEE Robotics and Automation Letters, 7(1), 88–95.