HybSi—High-precision Mechanisms at the Centimeter Scale based on Silicon Hybridization

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High-precision mechanisms at the centimeter scale can greatly benefit from the high-precision micro-structuration of silicon and its good mechanical properties. This approach opens up new opportunities for key Swiss industries such as the watch and scientific instrumentation industry. However, the handling and assembly of silicon is a challenge due to its brittleness. Combining its expertise in the domains of precision mechanisms and micro-manufacturing techniques, CSEM is taking up the challenge to become the Swiss competence center for the design, manufacturing, assembly and characterization processes of hybrid silicon-based mechanisms.

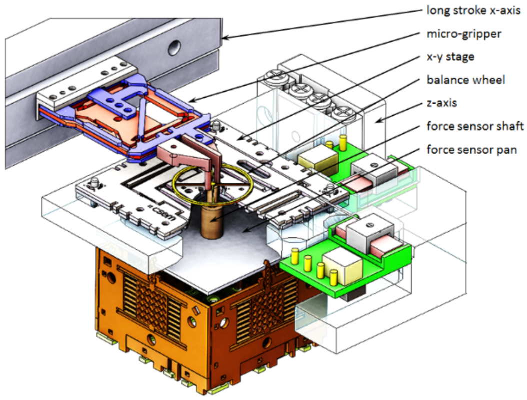

Figure 1: Silicon-based micro-platform targeted for the assembly and characterization of MacroMEMS.

Inherited from the micro-electronics sector, the batch micro-structuration of silicon enables the design and production of mechanical parts with a micrometric precision at the centimeter scale. At a scale between MEMS and classical mechatronics, this approach, referred to as MacroMEMS, can be used for the design of precision mechanisms targeted for different industrial fields such the watch industry (new watch mechanisms) or scientific instrumentation (micro-gripper, precision XY tables, precision force sensor). Figure 1 shows a silicon-based platform that can be used for micro-assembly and characterization of such systems; the platform itself is a combination of three different silicon based mechanisms designed and produced at CSEM [1].

To enhance the functionalities of MacroMEMS parts, overcome the 2D structuring limitations of silicon processing and propose a cost effective alternative to wafer level assembly (Si/Si, Si/metal), CSEM believes that precise 3D printing on silicon is a promising approach (Figure 2) that can open up novel business opportunities. Following this approach mechanical, electrical, optical and fluidic interfaces can be designed and added to silicon parts; these functionalities can even be mixed together, offering a high level of integration.

Some tests have been conducted with different materials and adhesion promotors. A microfluidic demonstrator combining 3D printed microfluidic channels, 3D printed seals and 3D printed mechanical interfaces (including precise positioning and assembly functions) with a high-precision silicon-based micro-filter [2] and the use of a micro-pump [3] has been designed and produced (Figures 3 and 4).

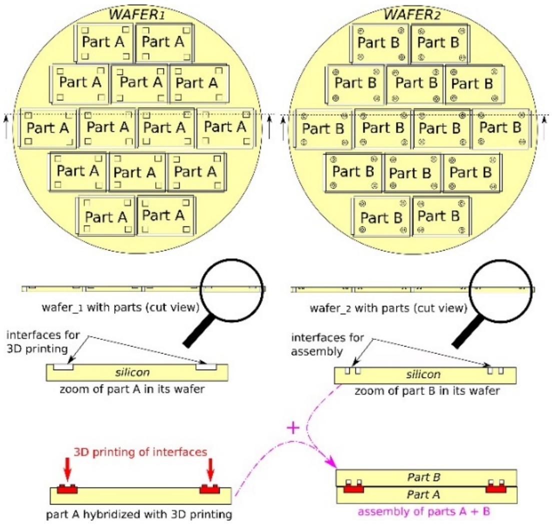

Figure 2: Interfacing and assembly of two silicon parts using precise 3D printing on silicon.

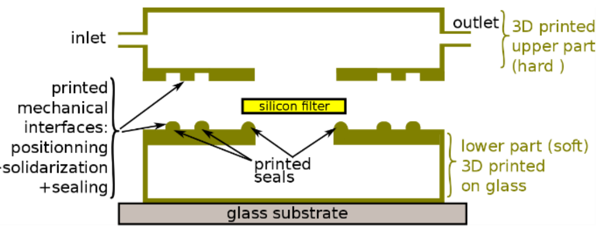

Figure 3: Precisely 3D printed parts comprising mechanical, fluidic and sealing functions, combined with a high-precision silicon filter.

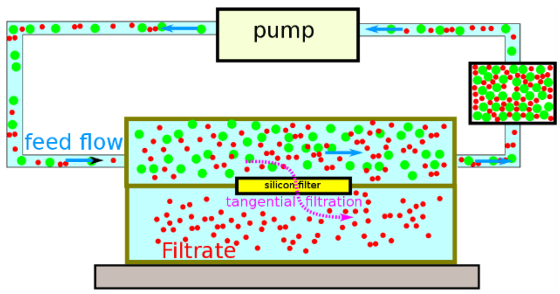

Figure 4: Working principle of the micro-fluidic filtering system.

[1] F. Cosandier, *et al.*, “A three device silicon based platform for micro-assembly and characterization”, EUSPEN 2016.

[2] R. Pugin, *et al.*, “IPoSiM – Integrated Porous Silicon Membranes”, CSEM Scientific and Technical Report (2013), 20.

[3] J. Goldowsky, *et al.*,”Turbisc Pump with an Integrated Flowsensor for Closed-loop Operation”, CSEM Scientific and Technical Report (2014), 112.