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Process Flow Date : 29.10.2025

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☒ Semestral Project ☐ Master Project ☐ Thesis ☐ Other

Diamond device for nano-fluidic flows

Description of the fabrication project

We build nanofluidic channels on the surface of a sensor made of diamond, in order to measure nanoscale water flows. The channels and reservoirs will be patterned with HSQ photoresist, and enclosed on the top with a PDMS cover, constituted of a patterned and of a perforated PDMS. For the substrates, CVD diamonds (4.5x4.5x0.3mm) will be used in a first step; diamonds with nitrogen vacancy centers implanted 3nm below their surface will be used in a second step.

Technologies used *!! remove non-used !!*
Mask fabrication, positive resist, negative resist, Lift-off, Dry etching, Wet etching, Spin-Coating, ebeam lithography, dicing

Photolitho masks			
Mask #	**Critical Dimension**	**Critical Alignment**	**Remarks**
1	~20nm	-	Ebeam channels
2	~1mm	-	Mask to pattern bottom PDMS, MLA SU8 1
3	~1mm	-	Mask to pattern top PDMS, MLA SU8 2

Substrate Type
CVD diamonds (4.5x4.5x0.3mm) or diamond implanted with nitrogen vacancies 3nm below the surface (4x4x0.3mm), Silicon test wafer

Interconnections and packaging of final device

Thinning/grinding/polishing of the samples is required at some stage of the process.
☒ No ☐ Yes => confirm involved materials with CMi staff

Dicing of the samples is required at some stage of the process.
☐ No ☒ Yes => confirm dicing layout with CMi staff

Wire-bonding of dies, with glob-top protection, is required at the end of the process.
☒ No ☐ Yes => confirm pads design (size, pitch) and involved materials with CMi staff

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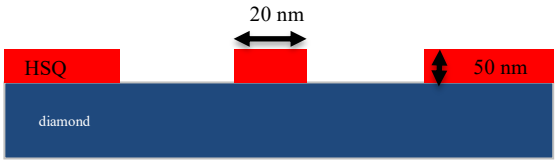
Step-by-step process outline

Step	Process description	Cross-section after process
	1st Part : Diamond and HSQ bonding	
01	**Substrate : C (diamond) for HSQ posts** *Surface cleaning with solvent (acetone → IPA →DI)* (Z13 or Z14) *Surface cleaning with O2-plasma* Machine: Tepla 300 (Z11)	
02	*HSQ coat for ebeam* Machine: Sawatec SM-150 (Z7)	
03	*Aluminum evaporation (20 or 30 nm)* EVA760 (Z11)	
04	*Ebeam exposure* Machine: EBPG5000 (Z7) or EPPG5200 (Z1)	
05	*HSQ development* CD26 or TMAH 25% (Z7) (Smallest channel is 20nm wide)	

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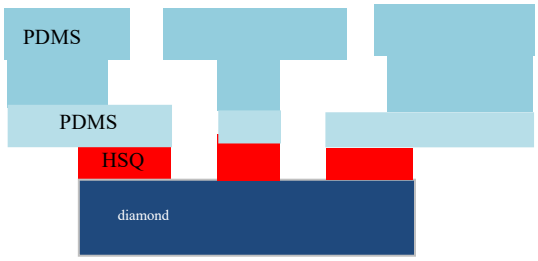
06/07	*HSQ Hardening* Tepla 300 High, 5min (Z11)	
	<u>2nd Part : Patterned PDMS</u> Perform this part for each PDMS layer, with different masks	
08/09	**Substrate**: ***Si for PDMS cover*** *Surface cleaning with O2-plasma* Machine: Tepla 300 (Z11) *SU8 Spin coating + soft bake* SU8 thickness: 2-5µm Machine : Sawatec-SM200 (Z13)	
10/11	*SU8 Exposure + Develop* Machine : Mask aligner MA6 Gen 3 (Z6) or MLA exposure *Post exposure bake Development (PGMEA)* (Z13)	
12	*TMCS anti-sticking treatment of the SU8 molds* *PDMS Casting / molding* (Z12)	
13	*PDMS bakeout + removal* (Z12)	
14	*Punch holes in PDMS* (Z12)	

	<u>3rd Part : PDMS assembly</u>	
15	*Assemble both PDMS obtained at step 14, after repeating twice part 2.* *Harrick plasma activation + bonding* (Z12)	
	<u>4th Part : Final assembly</u>	
16	*Bind HSQ and PDMS assembly* *Harrick plasma activation + bonding* (Z12)	

Rem. : Layer-by-layer design of the device, with required dimensions, is included below.

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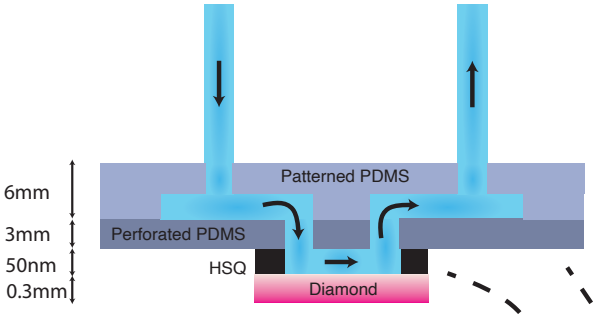
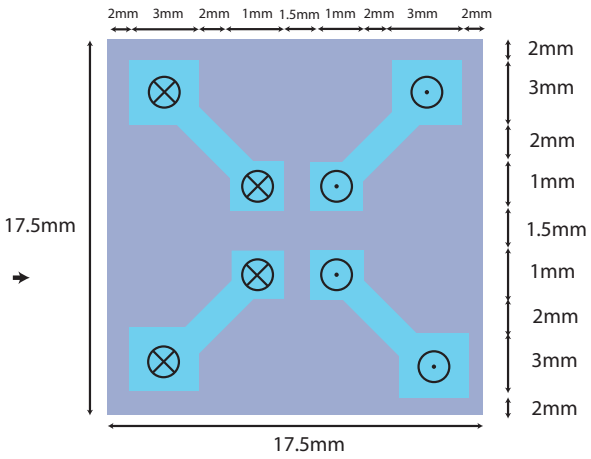
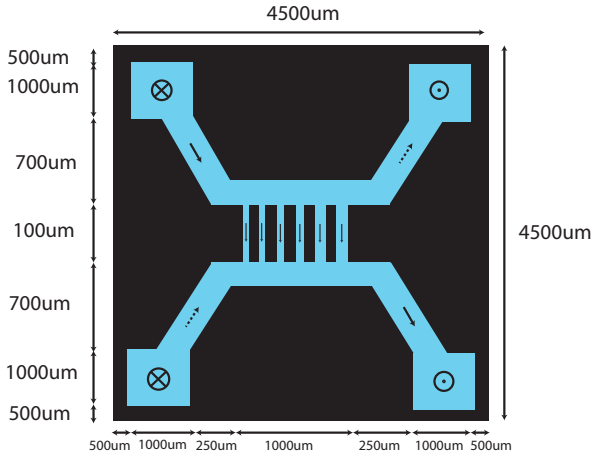
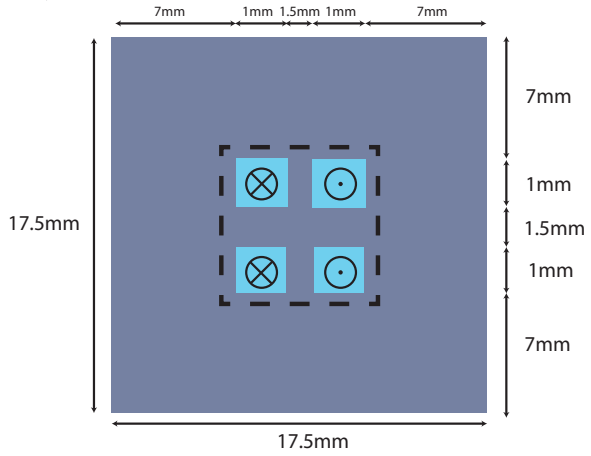




Notes : This scheme represents the patterned PDMS layer, that stands above the perforated PDMS layer. This PDMS layer is 6mm high. Water enters in reservoirs symbolized with a cross , and leaves from those with a dot. Punched holes inside the reservoirs (lightblue rectangles) have a diameter of 0.75mm. Channels linking the reservoirs have a width of 0.75mm.



Notes : This scheme, that is not to scale, represents the channels written with HSQ on top of the diamond surface. The HSQ layer is 50nm high. Water enters in reservoirs symbolized with a cross , and leaves from those with a dot. Full arrows represent water flow during measurement, and dashed ones the paths used to flush the reservoirs. The central zone with channels in series gathers 50 channels, spaced by 10um one from another. Channel dimensions, that are each replicated five times, are the following : 20nm, 40nm, 60nm, 80nm, 100nm, 200nm, 400nm, 600nm, 800nm, 1'000nm. The channels linking the reservoirs to the central zone are 50um wide.



Notes : This scheme represents the perforated PDMS layer, that stands between HSQ and the patterned PDMS cover. This PDMS layer is 3mm high. The black dashed square shows the position of the 4.5x4.5mm diamond that has HSQ on top. Water enters in reservoirs symbolized with a cross , and leaves from those with a dot. Punched holes inside the reservoirs (lightblue rectangles) have a diameter of 0.75mm.