Activity description

Describe your work in a step by step list below, or submit a copy of your synthesis pathway. Please remove the examples before you hand in the form.

If you are doing characterization only, skip this section and fill out section Characterization only.

Operation of every instrument requires a license in LIMS. Licenses are issued after participation on the instrument course in question, where instrument risks are covered. Users must be familiar with the risk matrix for all instruments that they use. Information about all instruments can be found on ntnu.norfab.no.

Step		Risks involved	Risk reducing measures
1	**Wafer Clean** (if necessary) Piranha solution ($3xH_2SO_4$ +$1x$ H_2O_2) **RCA Clean** (if necessary) SC-1: $1xNH_4OH$+$1x$ H_2O_2+$5x$ H_2O SC-2: 1x HCl +$1x$ H_2O_2+$5x$ H_2O H_2O rinse and dry	Highly oxidising, reacts violently with organics, highly corrosive, exothermic, can reach 100°C Corrosive, heated to 75°C	Fumehood; Wear apron, faceshield and acid gloves; no organics on surface, slowly mix peroxide into acid. Use heavy duty beakers and waste bottle with red cap. PPE as for Piranha. Add acid/base to water, not other way round. Both require buddy
2	**Deposition of 1st metal layer stack** Sputter clean 20 nm Cr or Ti adhesion layer 200 nm Pt or Au electrode layer 20 nm Cr or Ti adhesion layer by sputter deposition or e-beam evaporation		
3	**Photolithography** Dehydration bake Resist spin (S1823 or AZ9260), softbake at 115°C Exposure Development in MF319 or similar base Descum in O_2 plasma	Solvent exposure	Do not inhale fumes
4	**1st metal layer stack etching** <u>Dry etch</u>: ICP-RIE using Cl_2 & CF_4 or sputter etching *or*	ICP-RIE: Need to consider platen temperature needs to be above 70°C at least to avoid redeposition of Pt, Au not currently possible – potential issues with resist at higher temperature, may need to use hardmask or sputter etch at lower temperatures instead, or consider wet etch (tried and tested)	Keep platen temperature below 70°C (?) if using resist in chamber. Do not exceed 500 V DC bias to avoid burning out Pt thermocouple in chamber, as advised by Oxford instruments

	Wet etch: **Ti**: 1xNH_4OH+2x H_2O_2 (<100 ml) **Cr**: CR14 (<100 ml) (22% ceric ammonium nitrate, 9% glacial acetic acid, 69% DI water, by weight) **Au**: 8g KI, 2g I_2, 80 ml DI water *or* 80 ml of transparent etch (20 g I2, 80 g NH_4I, 600 ml ethanol, 400 ml dI H_2O) **Pt**: pre-sputter in Ar plasma 2 min, then Aqua regia at 50°C (25 ml HNO_3+50 ml HCl) Photoresist strip in acetone 10 min O_2 plasma strip	Corrosive Corrosive Highly Corrosive, reacts violently with organics	Apron, Faceshield, acid gloves, extracted wet bench for al the metal wet etches. In addition to above PPE, buddy is presumably required for this, use small amount only. No organics on surface.
5	O_2 plasma clean **PECVD deposition of insulator** SiO_2, Si_3N_4 or Al_2O_3	Silane gas	Pump chamber/loadlock three times
6	**Photolithography (S1813)**	As before	As before
7	**RIE etch of 1st insulator** Using CHF_3, O_2, Ar Photoresist strip in acetone 10 min O_2 plasma strip	Click to write text	Click to write text
8	**Deposition of 2nd metal layer stack** Sputter clean 20 nm Cr or Ti adhesion layer 200 nm Pt or Au electrode layer 20 nm Cr or Ti adhesion layer by sputter deposition or e-beam evaporation	Click to write text	Click to write text
9	**Photolithography (S1813)**	As before	As before
10	**2nd metal layer stack etching**	As before	As before
11	**2nd PECVD deposition of insulator layer**	As before	As before
12	**NIL** PDMS stamp preparation Amonil spin SCIL nanoimprint on MA6 mask aligner	Need additional information on this, I see one of the steps requires an HF etch of the glass carrier plate to remove micro-cracks; is this really necessary?	Work in fume hood, wear suitable gloves and PPE
13	**RIE etch of 2nd insulator layer**	As before	As before
14	**2nd metal layer stack nanowell etching** ICP-RIE using Cl_2 & CF_4	As before	As before
15	**RIE etch of 1st insulator**	As before	As before
16	**Photolithography**	As before	As before
17	**Electroplating Ni/Au**	Done externally	Done externally
18	**Photolithography**	As before	As before
19	**Scribing/Dicing**	Small particular matter	Wear gloves and safety specs

20	**Flip Chip Mounting & Underfill** Using solder beads *or* indium / gallium mix *or* wirebonder Underfill with UV curable epoxy or Masterbond EP30Med Acetone, IPA, H_2O clean O_2 descum	Gallium – suspected renal toxicity in large doses, potential for contact dermatitis Indium – considered non-toxic in pure form	Very small amounts used
21	**Silanisation** Vapour phase silanisation in dry N_2 or Ar atmosphere using max. 1-2 ml 3-APTES or 3-GEOPS. Bake at 120°C, wash in acetone, IPA, H_2O clean O_2 descum	Silanes: Corrosive, harmful, irritant; Harmful if swallowed. Causes burns.	Safety Goggles, appropriate gloves Use only in extracted wet bench.

What risks are involved in case power, process gases, N_2, water or pressurized air supply is cut?
Wet etching: Power supply loss would stop extraction of hazardous gases from fume hood. Loss of water supply would be hazardous in case of a spill Equipment: valves actuated through pressurized air would stop to function, loss of water or liquid nitrogen would affect cooling on devices such as the PECVD/RIE and sputter coater. Process gasses: Loss of nitrogen would prevent correct purge and pumpdown cycle to remove dangerous process gases from chamber and loadlock on PECVD/RIE

Comments to the steps above, if any

Characterization

Operation of every instrument requires a license in LIMS. Licenses are issued after participation on the instrument course in question, where instrument risks are covered. Users must be familiar with the risk matrix for all instruments that they use. Information about all instruments can be found on ntnu.norfab.no. Please remove the examples before you hand in the form.

Information about all instruments listed can be found on ntnu.norfab.no

Instrument	Material to characterize	Comments
S(T)EM	Nanoholes through Au or Pt on Si3N4, SiO2, or Al2O3	Sample size can be cut to fit instrument. Conducting and non-magnetic.
Dektak or other Profilometer	Photoresist and etched metals/insulators on Si wafers	
Optical Microscope	Photoresist and etched metals/insulators on Si wafers	
Interferometer	Photoresist and etched metals/insulators on Si wafers	
AFM	200 nm or larger Nanoholes through metal insulator sandwich structure	

Comments to the information above, if any

Chemicals

Only “Name of chemical” is needed if you do not know the other details. The chemical archive on ecoonline.no shows the chemicals that are provided by NanoLab, and if buddy/logging is needed. For guest log in: Code 1560, username and password “nano”. Please remove the examples before you hand in the form.

If the chemicals will be heated, pressurized or mixed with other chemicals, a risk evaluation for this has to be submitted. NTNU’s standard risk evaluation forms (found on LIMS, under Info) or any other format of your choice can be used.

NanoLab's licenses related to chemicals (chemical handling license + area courses) do not give any education in safe handling of chemicals. Supervision or previous experience is a prerequisite for chemical work in the cleanroom.

Name of chemical	Provided by NanoLab	Buddy needed	Logging needed	Will be heated, pressurized or mixed with other chemicals
Ethanol (97%)	☒Yes ☐No	☐Yes ☒ No	☐Yes ☒No	☐ Yes ☒No
Conc. Nitric acid	☒ Yes ☐No	☒ Yes ☐ No	☐Yes ☒No	☒Yes ☐No
Conc. Sulphuric acid	☒ Yes ☐No	☒Yes ☐ No	☐ Yes ☒ No	☐Yes ☐No
Conc. Hydrochloric acid	☒ Yes ☐No	☒Yes ☐No	☐ Yes ☒No	☒Yes ☐No
Ammonium Hydroxide	☒ Yes ☐No	☒Yes ☐No	☐ Yes ☒No	☒Yes ☐No
Hydrogen peroxide 30%	☒ Yes ☐No	☐ Yes ☒No	☐Yes ☒No	☒Yes ☐No
Tween-20	☐ Yes ☒No	☐ Yes ☒No	☐ Yes ☒No	☐ Yes ☒No
Biotin-PEG12-NHS Ester	☐Yes ☒No	☐Yes ☒No	☐Yes ☒No	☐ Yes ☒No
Avidin	☐Yes ☒No	☐ Yes ☒No	☐ Yes ☒No	☐ Yes ☒No
Streptavidin	☐ Yes ☒No	☐ Yes ☒No	☐Yes ☒No	☐ Yes ☒No
Guanidine hydrochloride	☐Yes ☒No	☐ Yes ☒ No	☐ Yes ☒No	☐ Yes ☒No
Ethylenediaminetetraacetic acid (EDTA)	☐Yes ☒No	☐ Yes ☒No	☐Yes ☒No	☐ Yes ☒No
Acetone	☒ Yes ☐No	☐ Yes ☒No	☐ Yes ☒No	☐ Yes ☒No
IPA	☒ Yes ☐No	☐ Yes ☒ No	☐Yes ☒No	☐ Yes ☒No
3-aminopropyltriethoxysilane	☐Yes ☒ No	☐ Yes ☐No	☐ Yes ☐No	☒ Yes ☐No
(3-Glycidyloxy-propyl)trimethoxysilane	☐ Yes ☒No	☐ Yes ☐No	☐ Yes ☐No	☒ Yes ☐No
S1813	☒Yes ☐ No	☐ Yes ☒No	☐ Yes ☒No	☐ Yes ☒No
S1805	☐ Yes ☒No	☐ Yes ☒No	☐ Yes ☒No	☐ Yes ☒No
S1823	☐ Yes ☒No	☐ Yes ☐ No	☐Yes ☐No	☐ Yes ☒No
AZ9260	☐Yes ☒ No	☐ Yes ☒No	☐ Yes ☒No	☐ Yes ☒No

Comments to the information above, if any
Silanes will be used in PDMS area AZ 9260 is introduced in activity NL0132