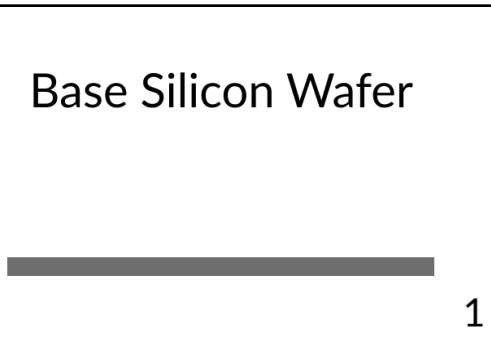
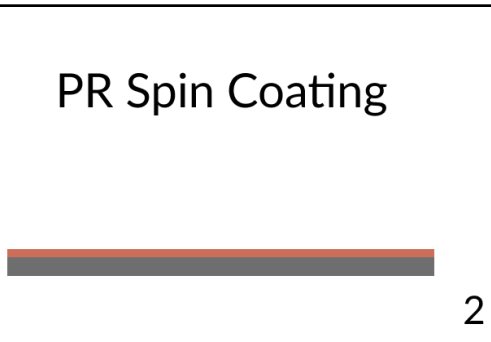
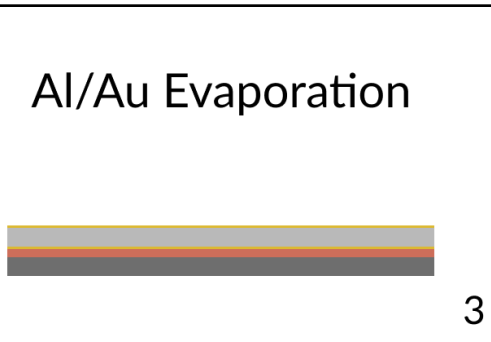
Process Flow

Goal

The goal of the project is to microfabricate a dielectric elastomer actuator (DEA) at the Toronto Nanofabrication Centre. This is the first step in building an artificial muscle fibre prototype.

Steps	Diagram
• Start with a 4” clean silicon wafer.	
• Clean wafer with H2O2 + H2SO4. • Dry with nitrogen gas. • Heat on a hotplate to remove moisture. • Spin coat AZ4562 photoresist at 4000 rpm for 30 seconds for a 6 µm sacrificial layer. • Bake at 100 degrees for 2 minutes.	
• Deposit metal electrode via e-beam evaporator. • 2 micrometers of Al, capped with 5 nanometers of Au on both ends to prevent oxidation. • Specific machine is the Angstrom Nextdep E-Beam Evaporator.	

• Mix Sylgard 186 PDMS monomer and curing agent 10:1 ratio and degas in vacuum desiccator. • Spin coat PDMS at 6000 rpm for 5 minutes for a 4 micrometer film. • Cure in oven at 150 degrees for 15 minutes.	PDMS Spin Coating  4
• Put wafer in an O2 plasma chamber for 5 minutes to increase surface roughness. • Specific machine is TePla Technics 100-E Oxygen Plasma Asher. • Repeat step 3 for Al/Au evaporation.	Al/Au Evaporation  5
• Repeat step 2 for photoresist spin coating.	PR Spin Coating  6
• Pattern the photoresist via photolithography. • Design photomask on L-edit. • Specific machine is the MA6 aligner. • Develop photoresist with AZ 340, in a 1:5 mix with water.	PR Patterning  7

• Etch the metal electrodes and PDMS until reaching the bottom photoresist layer. • Wet etch the metal electrodes. • Reactive ion etching with SF6 + O2 chemistry used to etch PDMS. • Specific machine is the Oxford PlasmaPro 100 Cobra ICP-RIE.	Reactive Ion Etching  8
• Put wafer in acetone solution and wait for dissolution of photoresist. • Dielectric elastomer actuator will be floating on the surface.	PR Dissolution  9
• Fabricate an accompanying Copper plated wafer. Add the cell to the wafer with the bottom electrode in contact. • Place the wafer under the probe station. Connect the input and output to observe compression when charged.	Characterization  10

Notes

- This article gives a good explanation for how to do the PDMS spin coating.
- To detach PDMS from Wafer use photoresist sacrificial layer. AZ4562 photoresist is good.
- This paper gives a good explanation for how to do photolithography + etch of PDMS.
- This paper deposits gold film on the PDMS via e-beam evaporation.
- This paper is on increasing surface adhesion of Au film on PDMS through O2 plasma treatment.