Monitoring the deflection of a Membrane using Direct UV Written Planar Bragg Gratings

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Abstract: A thin (~100 μm thick) silica-on-silicon square membrane (10 mm x 10 mm) has been fabricated and its deflection monitored through a 100 Bragg grating array defined within the membrane.

Membranes are an effective means to monitor pressure differentials and flow in both pneumatic and hydraulic systems [1]. The following work has mapped the deflection profile of a square membrane, using a 100 element planar Bragg grating array. The planar Bragg gratings have been fabricated in a silica-on-silicon substrate using a direct UV writing technique [2]. The membrane has been formed through selectively wet etching the underlying silicon with KOH. As a result of thermal mismatch stress between the silica and silicon layers the membrane relaxes into a buckled state post etching. Using the Bragg grating array this inherent buckling can be spectrally mapped, illustrated in Figure 1.

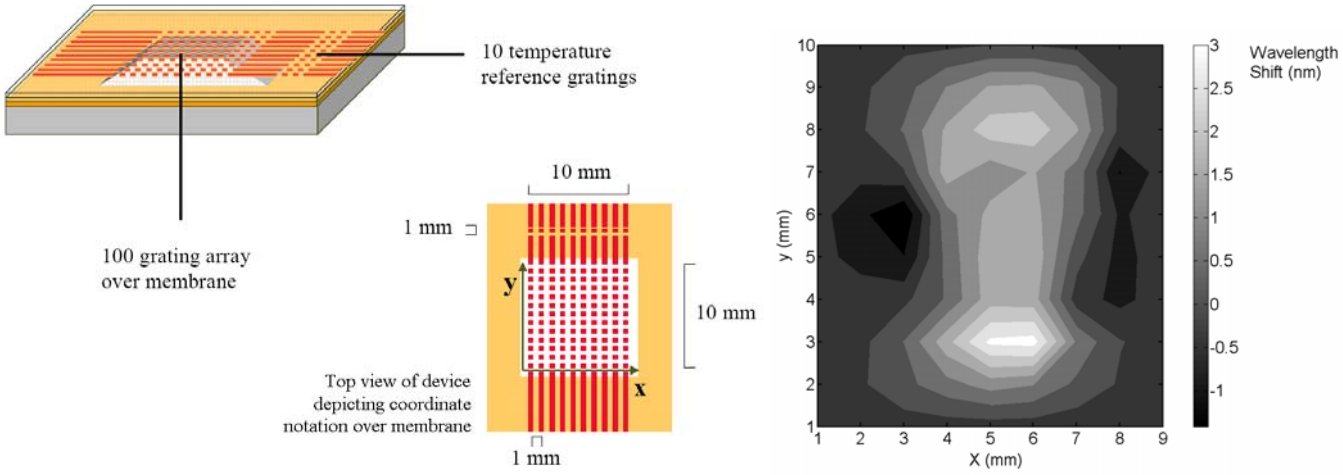

Figure 1 Schematic of the100 Bragg grating array over the fabricated membrane and the corresponding measured spectral shift map before and after the membranes wet etch.

The etched membrane relaxed into a state of first order buckling with the point of maximum deflection located at its centre and measured to be 182 μm, using a surface profiler. Furthermore through mapping the deflection of the membrane with the surface profiler the induced strain on the Bragg gratings can be inferred and a theoretical spectral response deduced [3]. This theoretical response showed a comparable shift to that measured experimentally. Using such a multiplexed array of Bragg gratings the degree of deflection can be attained remotely and the physical state of the membrane monitored.

References

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[3] T.S. Narasimhamurty, Photoelastic and electro-optic properties of crystals, Plenum, New York, (1981)