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High Aspect Ratio Sio2 Capillary Based On Silicon Etching and Thermal Oxidation Process for Optical Modulator

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Abstract : This paper presents the design and fabrication of an optical window for an optical modulator toward image sensing applications. An optical window consists of micrometer-order SiO2 capillaries (porous solid) that can modulate transmission light intensity by moving the liquid in and out of porous solid. A high optical transmittance of the optical window can be achieved due to refractive index matching when the liquid is penetrated into the porous solid. Otherwise, its light transmittance is lower because of light reflection and scattering by air holes and capillary walls. Silicon capillaries fabricated by deep reactive ion etching (DRIE) process are completely oxidized to form the SiO2 capillaries. Therefore, high aspect ratio SiO2 capillaries can be achieved based on silicon capillaries formed by DRIE technique. Large compressive stress of the oxide causes bending of the capillary structure, which is reduced by optimizing the design of device structure. The large stress of the optical window can be released via thin supporting beams. A 7.2 mm x 9.6 mm optical window area toward a fully integrated with the image sensor format is successfully fabricated and its optical transmittance is evaluated with and without inserting liquids (ethanol and matching oil). The achieved modulation range is approximately 20% to 35% with and without liquid penetration in visible region (wavelength range from 450 nm to 650 nm).

Keywords : thermal oxidation process, SiO2 capillaries, optical window, light transmittance, image sensor, liquid penetration
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