A laser-assisted bonding method using a liquid crystal polymer film for MEMS and sensor packaging

TABLE I.

THE MECHANICAL THERMAL, ELECTRICAL AND ENVIRONMENTAL PROPERTIES OF 3908 LCP MATERIAL

Property	3908 LCP film
Tensile modulus	2450 MPa
Coefficient of Thermal Expansion (CTE)	17 ppm/℃
Melting temperature	280 ℃
Dielectric constant	2.9
Dissipation factor (10 GHz, 23℃)	0.0025
Chemical resistance	98.7 %
Water absorption (23℃, 24 hrs)	0.04 %

TABLE II. BONDING PARAMETERS AND THE RESULTS OF SHEAR AND LEAK TEST

Bonding assembly	Bonding area (mm^2)	Bonding parameters			Shear strength (MPa)	Standard deviation (MPa)	Leak rate (mbar l s^{-1})
		Laser power (W)	Time (s)	Force (N)			
Glass-glass	27.3	48	75	4	22.7	0.43	$1.1x10^{-9}$
Silicon-glass	15.7	23	40	4	21.6	0.36	$3.4x10^{-9}$
Silicon-silicon	15.7	35	40	4	26.1	-0.72	$2.1x10^{-9}$
Silicon-package	25.9	20	120	4	20.8	1.20	$6.5x10^{-9}$

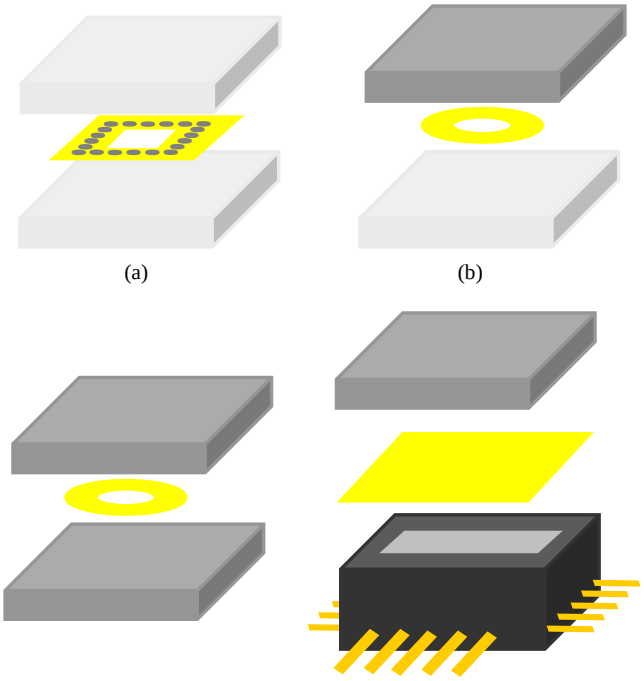


Fig.1. (a) Schematic view of package configurations using an LCP film, (a) glass to glass bonding with titanium-coated LCP film, (b) silicon to glass bonding with a LCP thin film ring, (c) silicon to silicon boning and (d) silicon to LCP package.

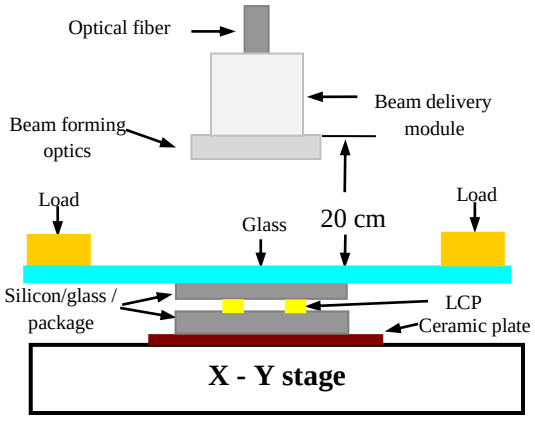


Fig. 2. Schematic of the laser bonding setup.

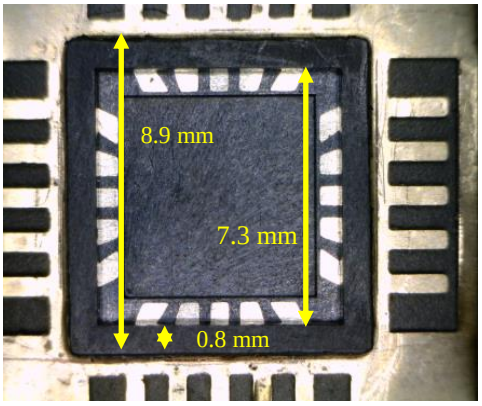


Fig. 3. A photograph of an LCP cavity package after surface polishing to remove the initial recess.

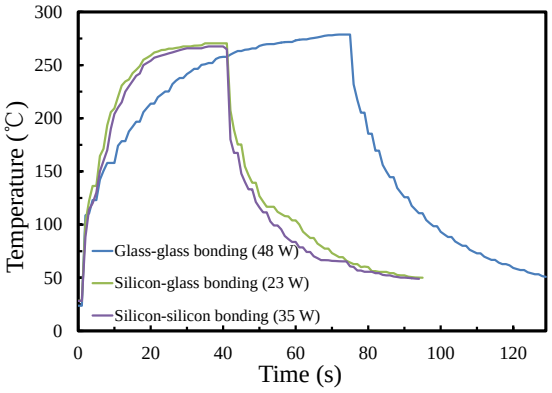
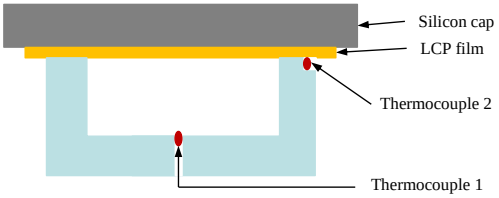
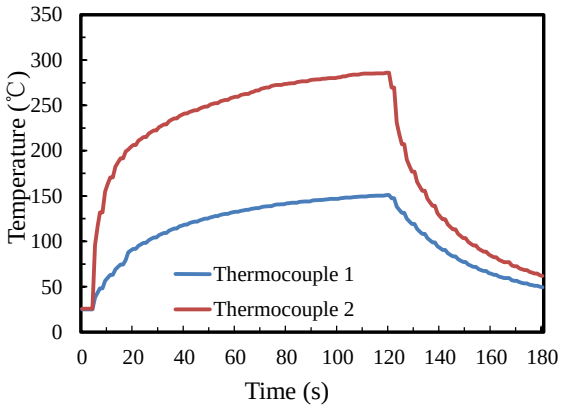


Fig. 4. Measured results of the laser induced temperature for LCP bonding of silicon and glass substrates.

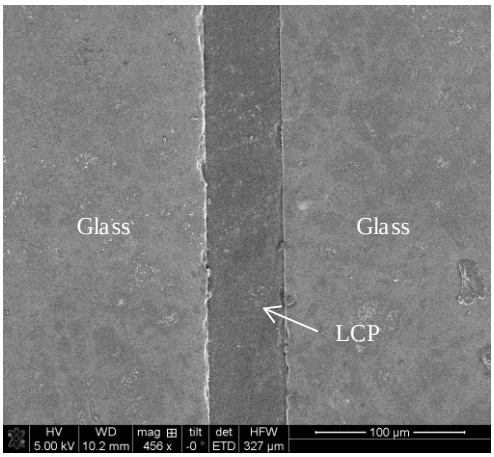


(a)

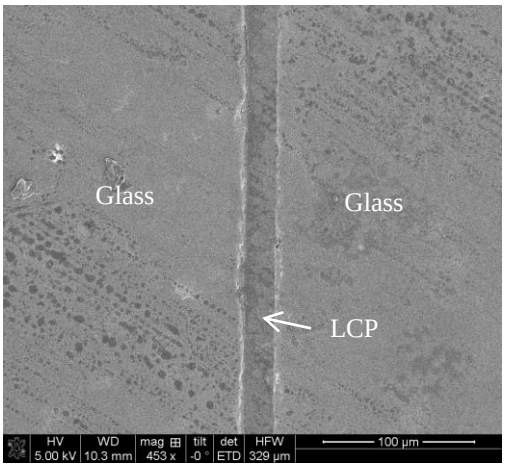


(b)

Fig. 5. (a) Schematic view of the embedded temperature sensors for bonding of silicon to LCP package. (b) Results of temperature measurements from the sensors.

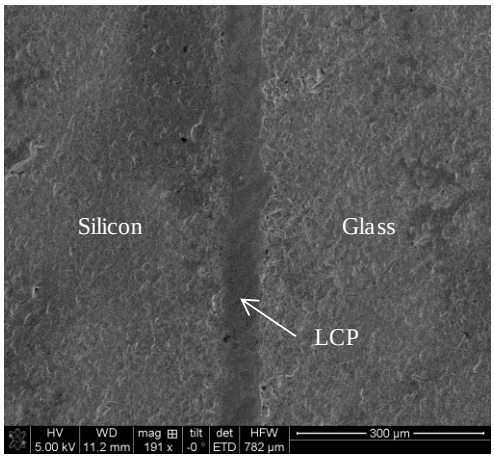


(a)

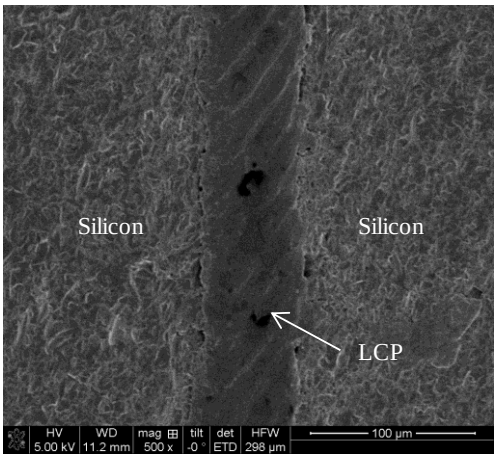


(b)

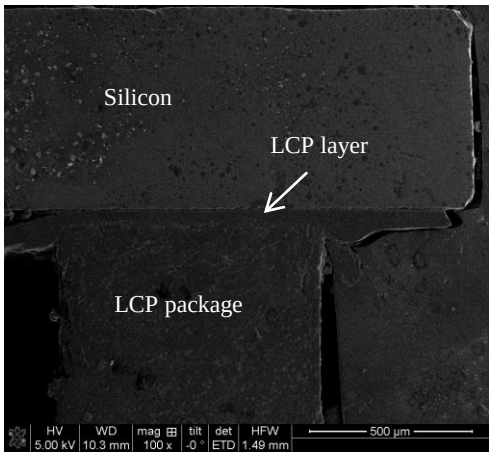
Fig. 6. SEM images of LCP bonded interface in glass-glass bonding for laser power of (a) 48 W and (b) 50 W.



(a)

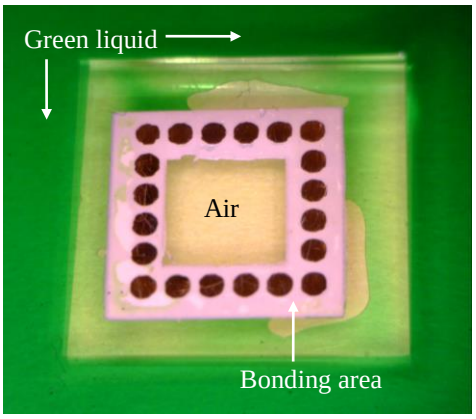


(b)

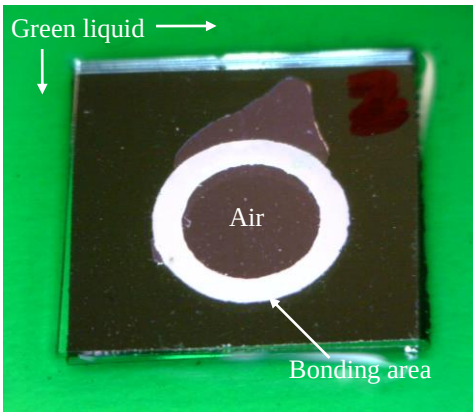


(c)

Fig. 7. SEM images of bonding interfaces using an LCP film, (a) silicon to glass, (b) silicon to silicon, and (c) silicon to LCP package.



(a)



(b)

Fig. 8. Optical pictures of bonded samples after immersion of 24 hours in a color liquid showing no leak, (a) glass to glass bonding and (b) glass to silicon bonding.