Liquid Crystalline Polymer- Based PCBMEMS

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ABSTRACT

We have employed a micron-scaled resolution, maskless photo-imaging/patterning tool to create structures both in photopolymer and separately in underlying polymeric substrates. The micro-device patterning tool in combination with the versatility of polymeric materials is useful for constructing fluidic channels, microdevices, microstructures and packages, utilizing any photoimageable or photoreactive material that can be applied towards fabrication of integrated microfluidic-based systems. The fabrication technology can provide features down to 10 microns simultaneously over a 2x2 cm^2 field of view. Additionally, applying manual and automatic stitching techniques can yield unlimited field of view for large area integrated microsystems with high-resolution elements.

The instrument creates mask free designs on planar and curved surfaces and has been applied to a variety of materials, including metals, ceramics, and organic polymers such as Liquid Crystalline Polymer (LCP). For this study, we have demonstrated the utility of the instrument for creating mechanical, optical, fluidic and electronic components and combinations that form the basis of integrated micro-fluidic systems, micro-analytical systems and micro-total analysis systems (uTAS) using LCP in a printed circuit board (PCB) MEMS format.

PCBMEMS FABRICATION MODEL

We have created water measurement systems using PCBMEMS or Laminate MEMS based on liquid crystalline polymer (LCP). The PCBMEMS packages embed the various sensing elements within the LCP laminates. Functions are created using the direct write technology combined with both plating and etching pattern transfer processes. Figure 1 provides standard process flow for fabricating common elements within a LCP based PCBMEMS system.

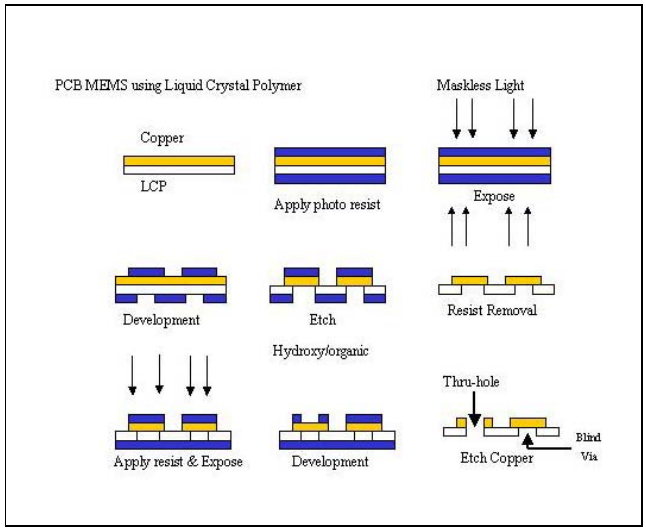

Figure 1. Process flow for PCBMEMS elements: through-hole,blind-via,and microcircuit/microchannel fabrication The process flow is for LCP/Cu patterning but will be similar for other PCB materials and cladding materials.

RESULTS/DISCUSSION

The following results illustrate a sampling of micro-sensors that can be fabricated using the photo-imaging tool and Liquid Crystalline Polymer. They include a pressure sensor that utilizes LCP's elastic properties, a heater, a resistor that is used to induce microflow via thermo-pneumatic actuation [6], and a micro-channel network demonstration within the LCP dielectric material for fluid transfer processes.

The devices shown in figures 2-5 illustrate that not only sensors can be easily fabricated by means of the described technology. A whole range of sampling systems, microfluidic devices and analytical systems can be readily fabricated facilitating the integration of complete analytical devices.

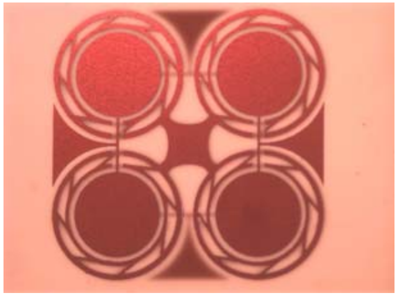

Figure 2: A pressure sensor fabricated using Copper clad LCP.

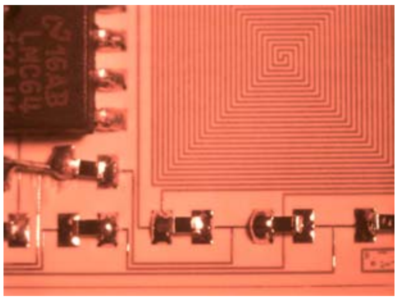

Figure 3: An integrated heater/sensor made from Cu clad LCP material that was electronic mask photo-patterned and etched with ferric chloride.

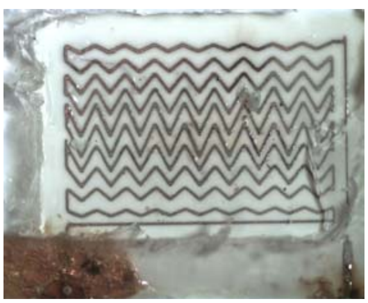

Figure 4: An optimized resistor with PDMS-walled-reservoir used for thermo-pneumatic actuation made in LCP with Cu/Zn conductors.

Figure 5: Microchannels etched in LCP dielectric polymer.

CONCLUSIONS

By using the direct write photopatterning tool and Liquid Crystalline Polymer/metal clad systems the fabrication of PCBMEMS micro-systems can be achieved very easily and in a competitive fashion to standard MEMS processing. We have designed and fabricated several sensors for in water detection of chemical, biological and physical parameters for in-situ measurements. In addition, micro-fluidic components for micro-analytical systems are also in the works using the materials and the equipment described herein.

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