Transparent PZT piezoelectric membranes for MEMS applications

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Lead zirconate titanate (PZT) is the most powerful piezoelectric material, especially for microactuator applications. The PZT based MEMS technology is today well established and mastered in industry. Thin film piezoelectric stacks are deposited onto silicon substrate and implement nontransparent layers (electrodes, metallization). One current great challenge is to integrate PZT, or other piezoelectric materials like AlN, in transparent MEMS devices for various application domains that may require transparency like haptics, human-machine interface, acoustics, selfcleaning. However, the crystallization at around 650-700°C of the PZT film does not allow it to be deposited directly on an SiO_2 membrane and / or transparent electrode, such as ITO. PZT films are indeed most often grown on platinized Si substrate. A solution to this problem is to transfer the PZT thin film, together with a transparent electrode deposited on top of it, from a growth Pt/Si substrate to a host substrate (transparent or not), following a process recently developed [1]. We report here for the first time the realization of fully transparent ITO/PZT/ITO parallel plate capacitor on SiO_2 membrane, obtained by layer transfer process (Figure 1). The piezoelectric membranes obtained on 200 mm Si wafer are electrically functional and show average transparency of 75% in visible spectrum. The actuation of membranes was demonstrated and measured under applied voltage. This proof of concept opens the way to the fabrication of transparent Piezoelectric Micromachined Ultrasonic Transducers (PMUT) devices for fingerprint application or else.

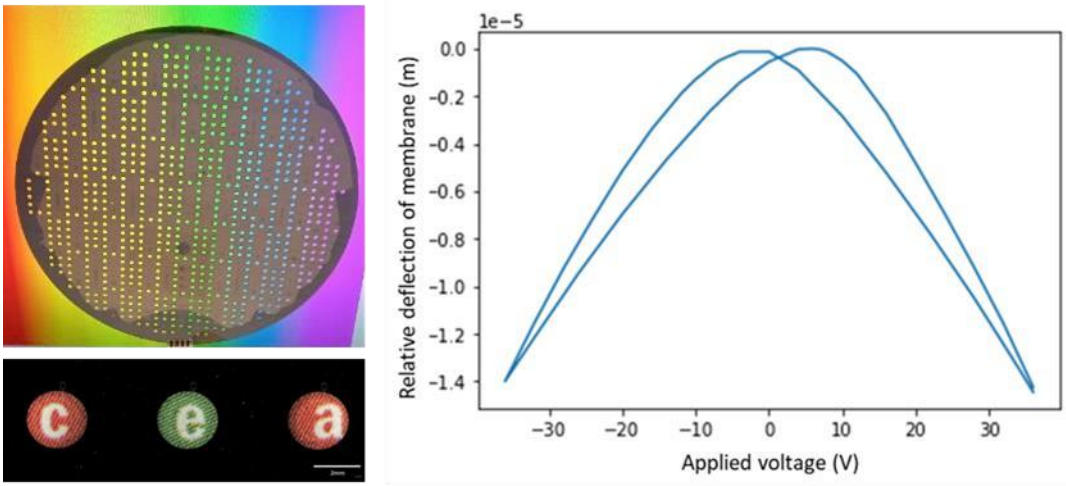

Figure 1: photography of transparent PZT based membranes on 200 mm Si wafer, and displacement Vs voltage curve of a disk actuator membrane.

References

[1] G. Le Rhun et al., *Proc. IEEE TRANSDUCERS 2019, pp. 1800-1802*