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► **To cite this version:**

Gwenael Le Rhun, Franklin Pavageau, Christel Dieppedale. New challenges for piezoelectric MEMS. MATELEC 2020 - Matériaux Electroactifs et Applications, Jul 2022, Villeneuve d'Ascq, France. cea-03884669

HAL Id: cea-03884669

<https://cea.hal.science/cea-03884669>

Submitted on 5 Dec 2022

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New challenges for piezoelectric MEMS

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Lead zirconate titanate, $\text{Pb}(\text{Zr,Ti})\text{O}_3$ (PZT), has been the most studied piezoelectric thin film for MEMS actuators the last two decades due to its high transverse piezoelectric coefficient d_{31} . The PZT technology is now available in several MEMS foundries and PZT thin film actuators are already integrated in commercialized devices like inkjet printheads, micro-speakers and autofocus camera. Emerging applications such as micro-mirror for LIDAR, haptics for human-machine interface, micro-pumps, as well as PMUT for fingerprint, medical probe or gesture recognition are also based on thin film PZT actuators. The potential of use of PiezoMEMS is thus expanding, but it may require to functionalize non silicon substrate (Glass, Flex, Metal,...), large surface (smart windows), curved surface (haptics). In some cases also, transparency is requested.

One of the constraints that limit the use of PZT in microsystems is its high crystallization temperature, usually from 500°C to 700°C depending on deposition method/process. It is thus very complicated to integrate PZT on Si for Above IC applications (Temp <450 °C), glass substrate (optical applications, haptics) or flexible (low cost applications, large format) as require for some applications. Low temperature deposition processes and film transfer techniques are the main ways to bypass the thermal budget issue. At Leti, we developed a technological process that allows transferring films stack from silicon substrate to any other substrate. It was used for transferring high quality sol-gel deposited PZT films from silicon growth substrate to either Si, glass or polymer. The transferred PZT film keeps its high (100) texturation obtained during deposition, which is required for optimal piezoelectric properties. PZT based devices subsequently fabricated as test vehicles show excellent ferroelectric and piezoelectric properties. In this presentation, we will show the potential of this process for realizing non standard piezoMEMS devices such as capacitors on glass [1,2] or transparent PZT membranes [3].

References:

- [1] F. Casset et al., *Proc. IEEE MEMS 2019*
- [2] G. Le Rhun et al., *Proc. IEEE TRANSDUCERS 2019*, pp. 1800-1802
- [3] To be published