A Novel Co-casting Process for Multilayer Ceramics

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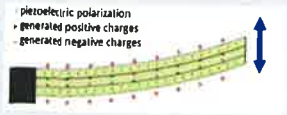
Motivation

Piezoelectric multilayer be used as bending transducer in vibration energy harvesters

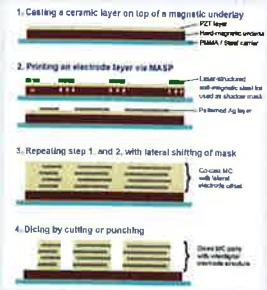


Target

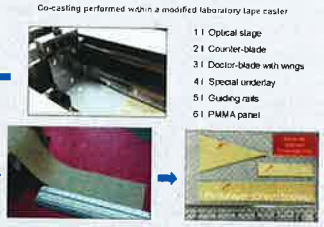
- Development of a **lab-scale process for low-volume production of multilayer ceramics** (MCs)
- Realizing **layer thicknesses < 100 µm** in co-fired MCs
- Realizing an **interdigital electrode structure** (IDE)

- Development of a **PZT-based low-temperature co-firing piezoceramic powder composition**
- Realizing **pure silver inner electrodes** in piezoelectric vibration energy harvesters (PEH)

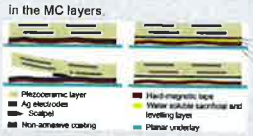
Co-casting



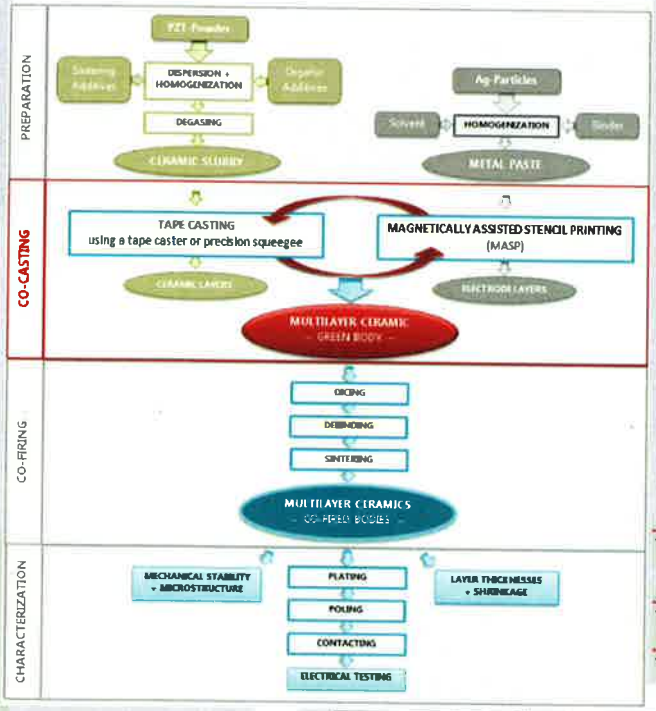
The advantage of co-casting is that the entire multilayer manufacturing process can be performed simply by means of a squeegee or a small tape casting machine and since no freestanding films need to be handled thicknesses below 100 µm can be realized in the green state of the MCs (<20 µm in the co-fired state).



A special underlay with a soluble sacrificial layer enales a chemical detachment of the green body from the casting underlay. It was developed to avoid cracks in the MC layers.



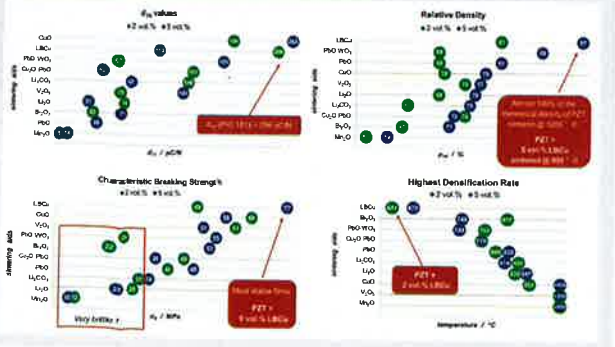
From powder to component



Feedstock

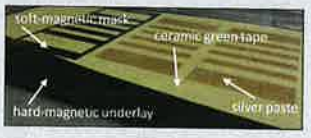
Formulations for the PZT-slurry and the Ag-paste were de-veloped iteratively to adopt an uniform and crackfree drying and sintering shrinkage of both materials

Ten different metal oxides were investigated as sintering additives for a commercial PZT powder (PIC 181, PI Ceramics) to lower its T_{inter} from >1200 °C to 900°C and enable co-firing of PZT-based MCs with inner electrodes made of silver.



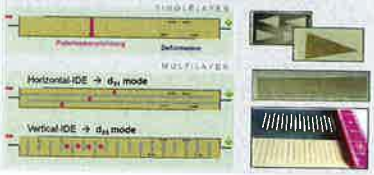
MASP

The magnetically assisted stencil printing method was developed to apply well-defined electrode areas on top of a ceramic green foils.



It is used as an alternative for the commonly used screen-printing process which could not be integrated into the tape casting process to enable a subsequent casting of several layers on top of other (co-casting). The soft-magnetic masks (t > 50 µm) were fabricated using a laser marker:

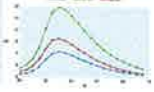
H – IDE vs. V – IDE



Testing

Most MCs with very thin layers could not be poled due to short circuits.

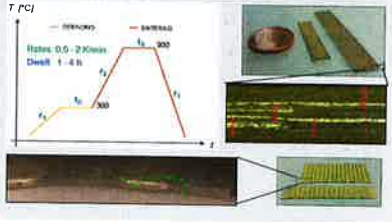
An output voltage of 6V was measured for a V-IDE-double-layer



Co-firing

Co-firing was performed successfully @ 900 °C. Layer thicknesses below 20 µm could be realized in the co-cast MCs after sintering:

THIN FILM TECHNOLOGIES	CO-CASTING	THICK FILM TECHNOLOGIES
few nm – 10 µm	20 µm – several mm	100 µm – cm



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