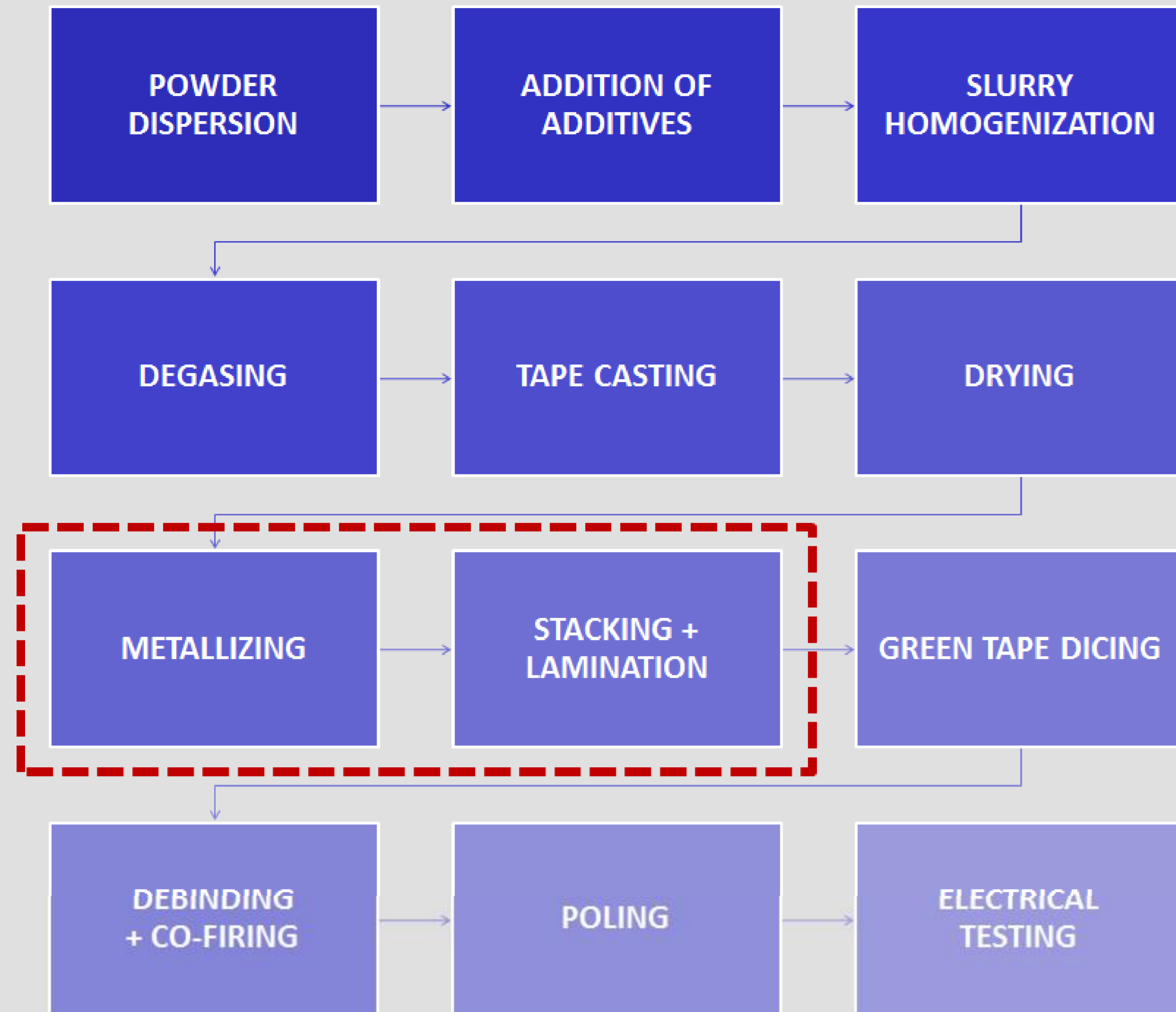


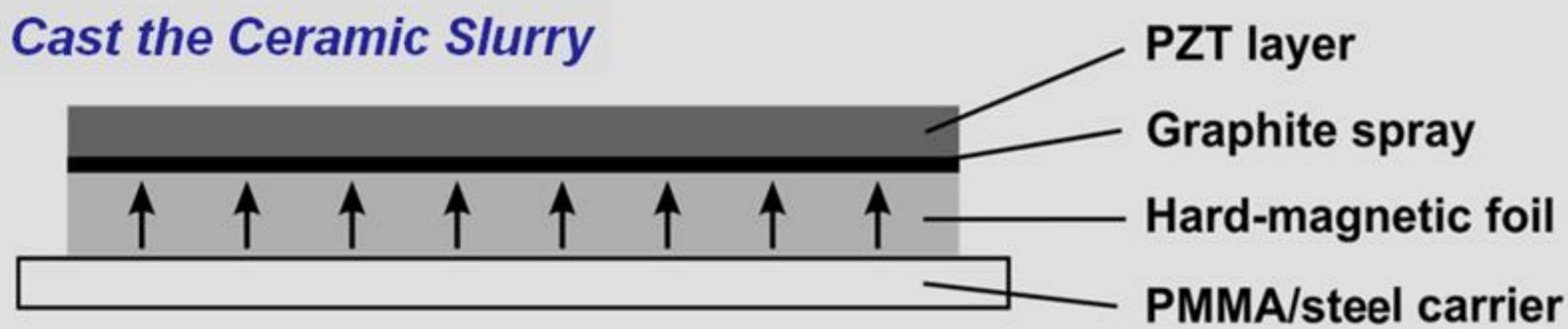
Fabrication of Multilayer (ML) Devices



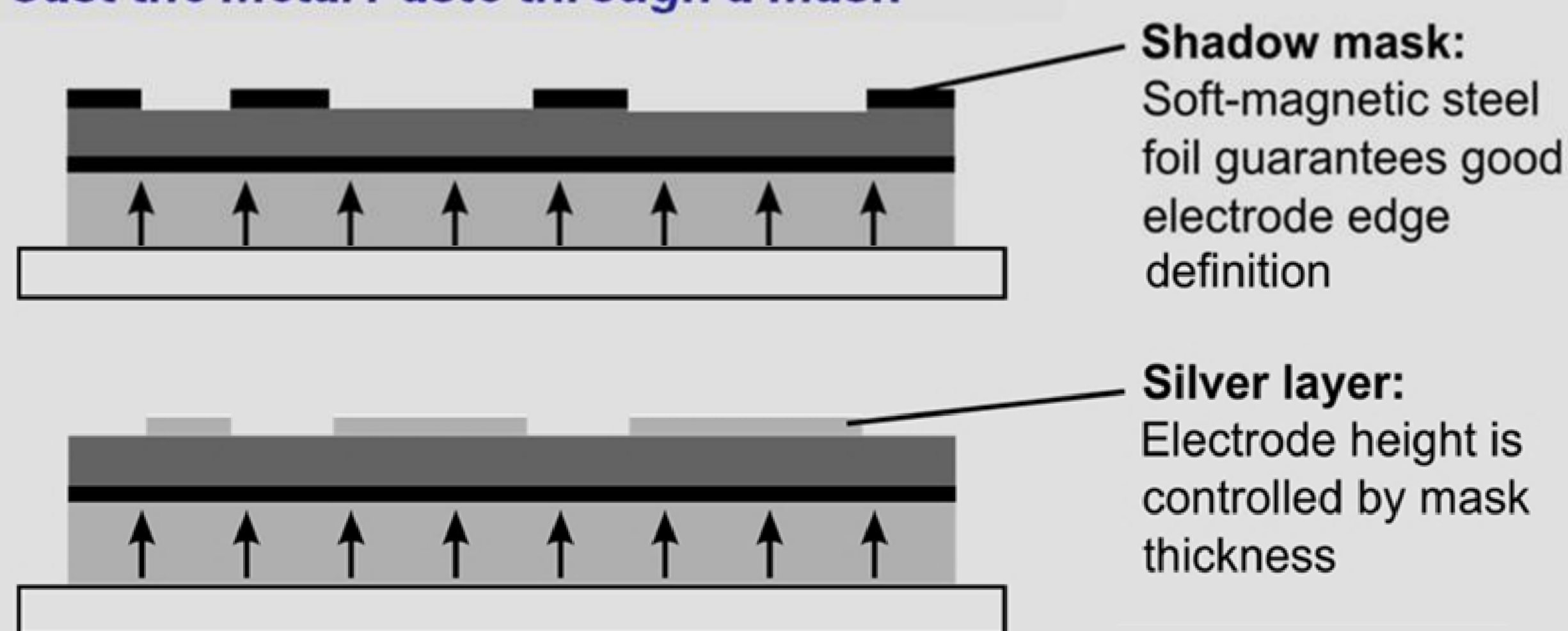
Optimized for MLs with Thin Ceramic Layers

Process Flow of Co-casting

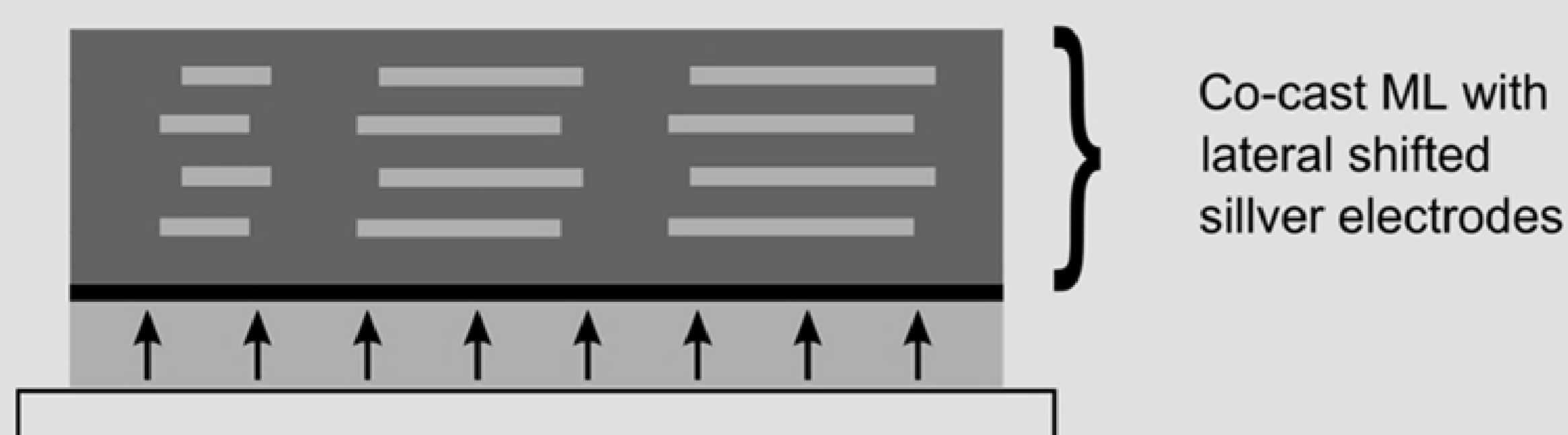
1. Cast the Ceramic Slurry



2. Cast the Metal Paste through a Mask



3. Repeat Steps 1. and 2. with Lateral Shift of the Mask

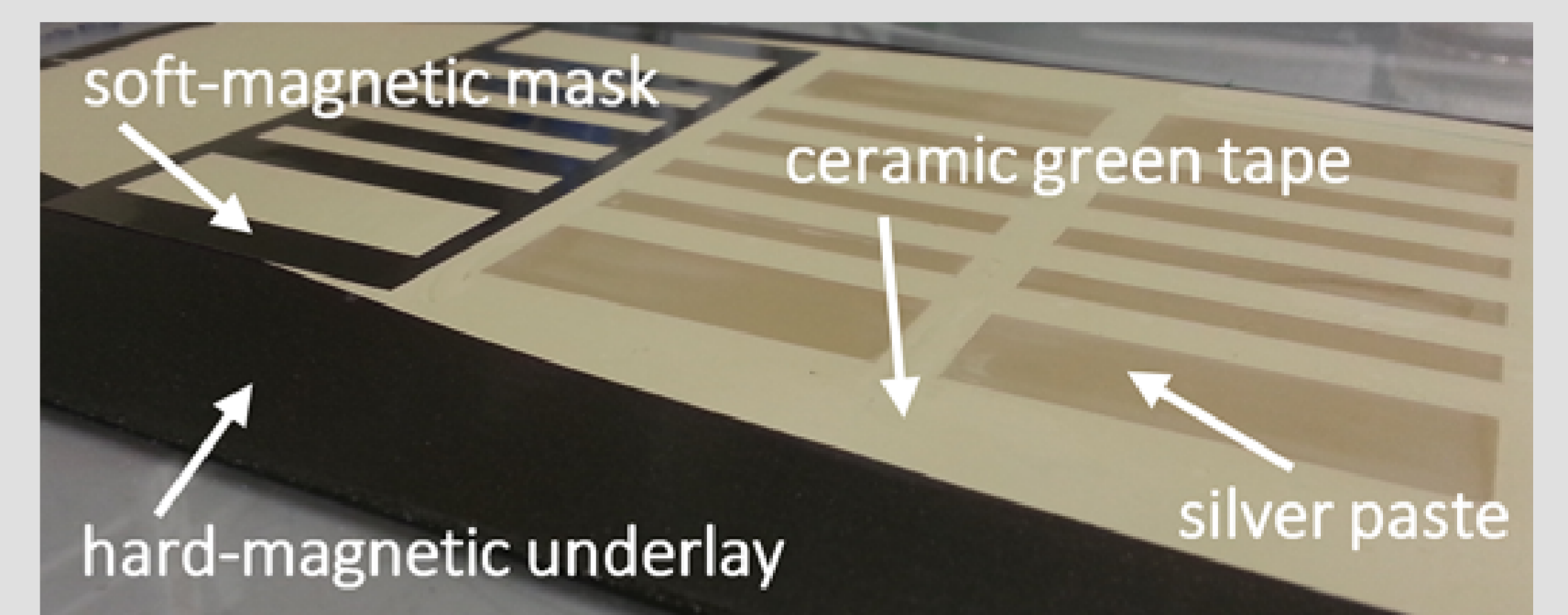


4. Dice by Cutting or Punching



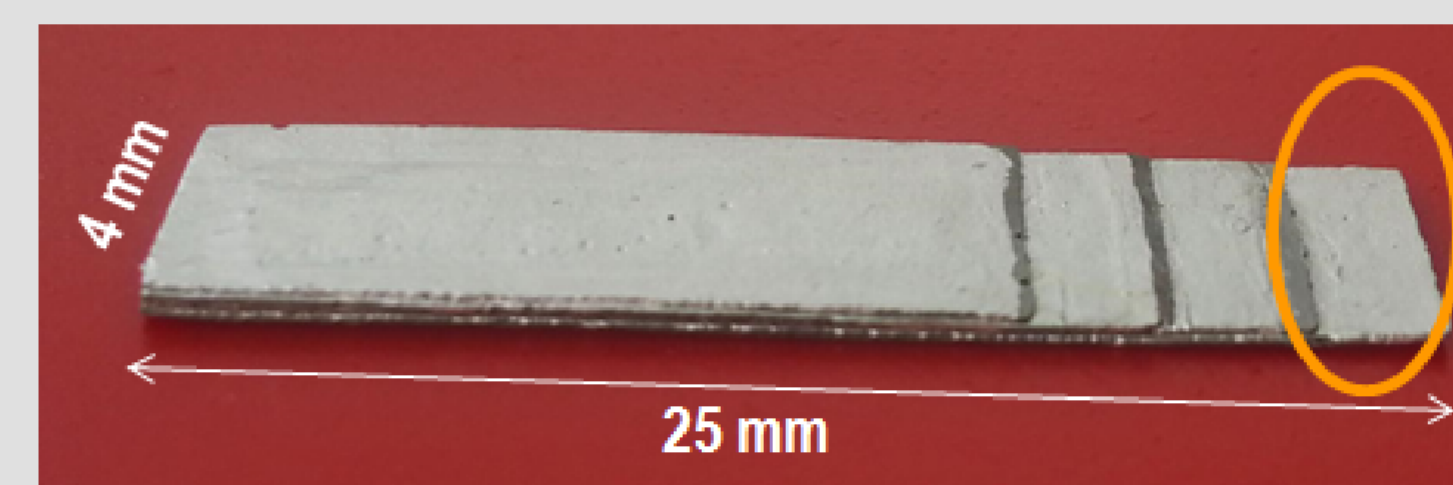
The Idea: Magnetic Fixation of the Mask

Defined metallization of the ceramic green tapes was realized by use of a magnetically attracted mask. The firm fixation of the mask guarantees electrode areas with a high edge definition.



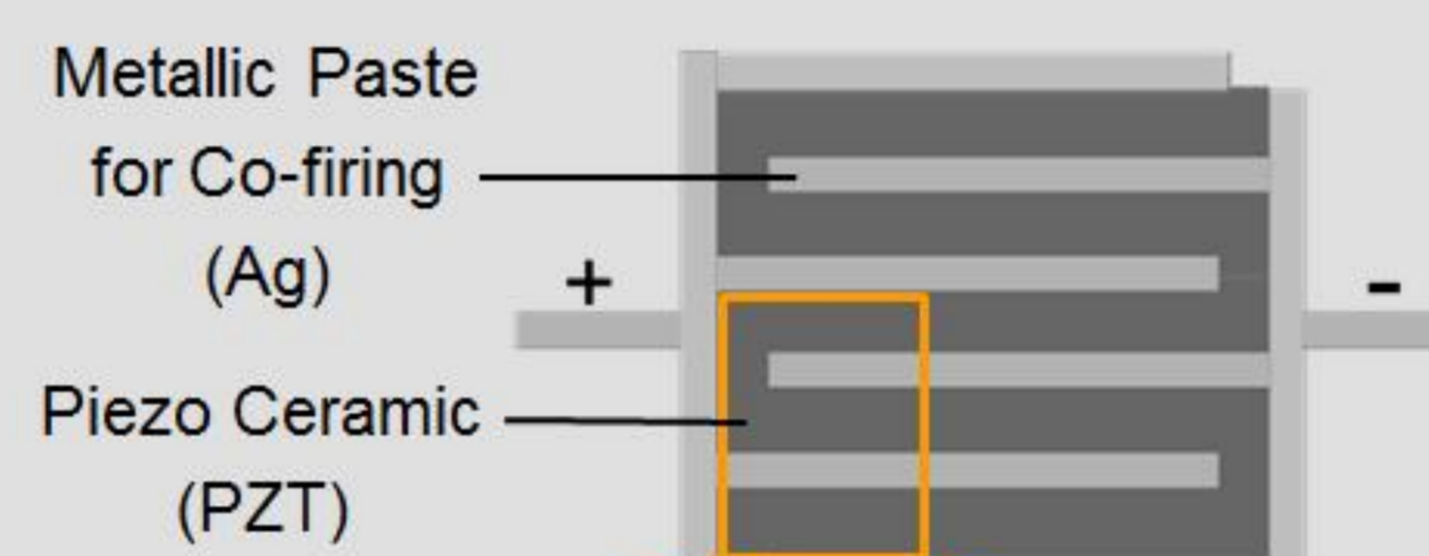
Interdigital Electrode Structure

Problem:

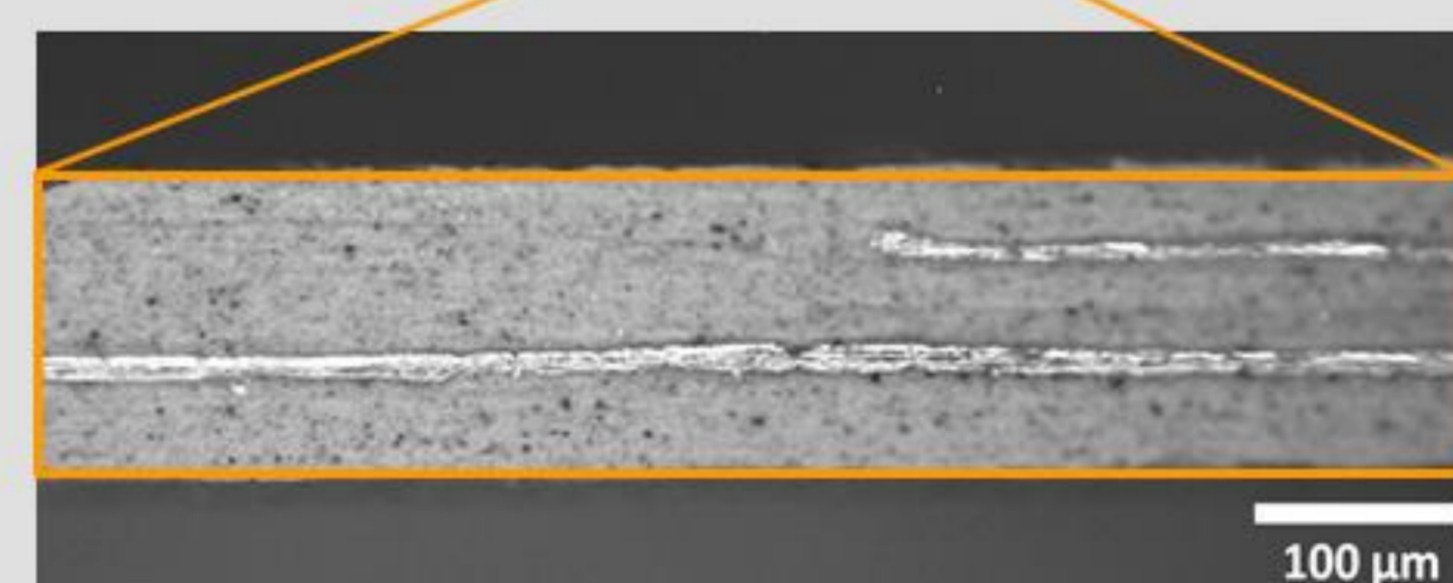


Freestanding ceramic layers with thicknesses below 100 μm are not mechanically stable enough to contact the inner electrodes in a stepped layer structure.

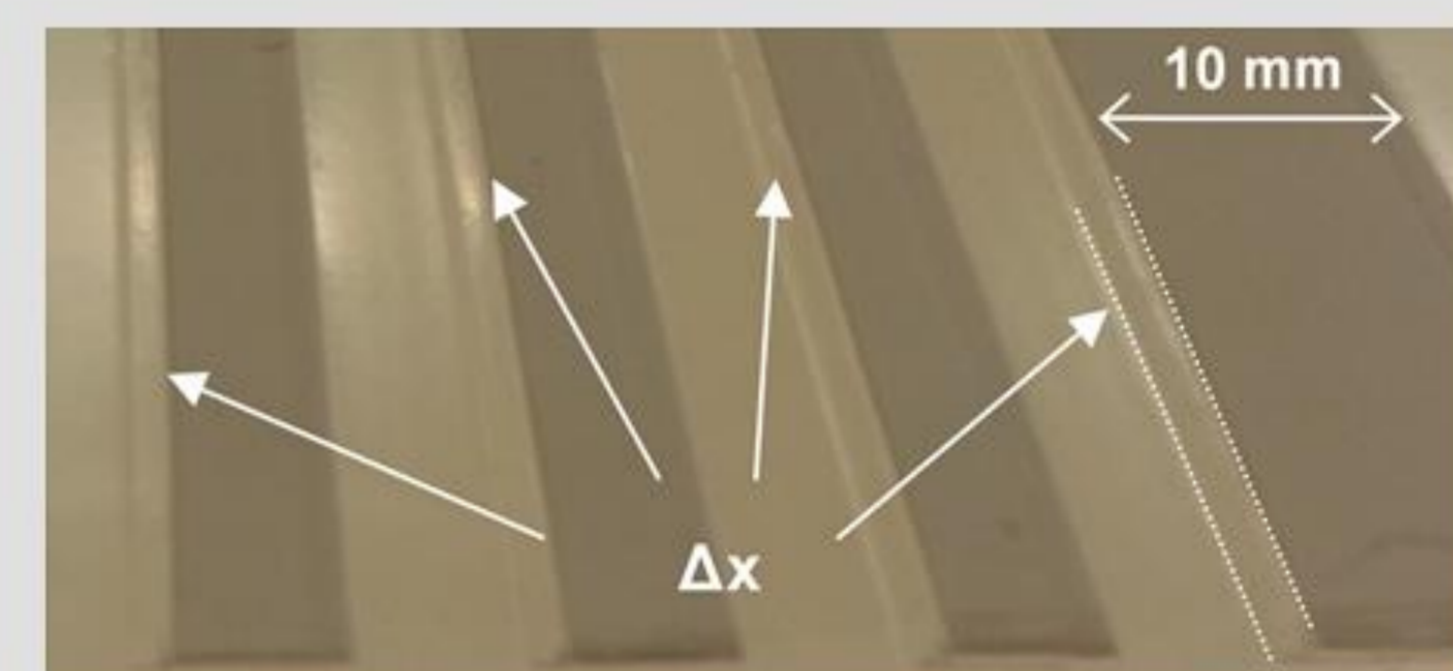
Solution:



An interdigital electrode structure allows contact of the inner electrodes from the ML sides. Therefore, a non-continuously metallized green tape surface and metallized areas with sharp edges are required.



This cross section of a co-cast and co-fired @ 900 °C piezoelectric ML (consisting of three PZT layers and two silver inner electrodes) shows that the inner electrodes are continuous only to one side.

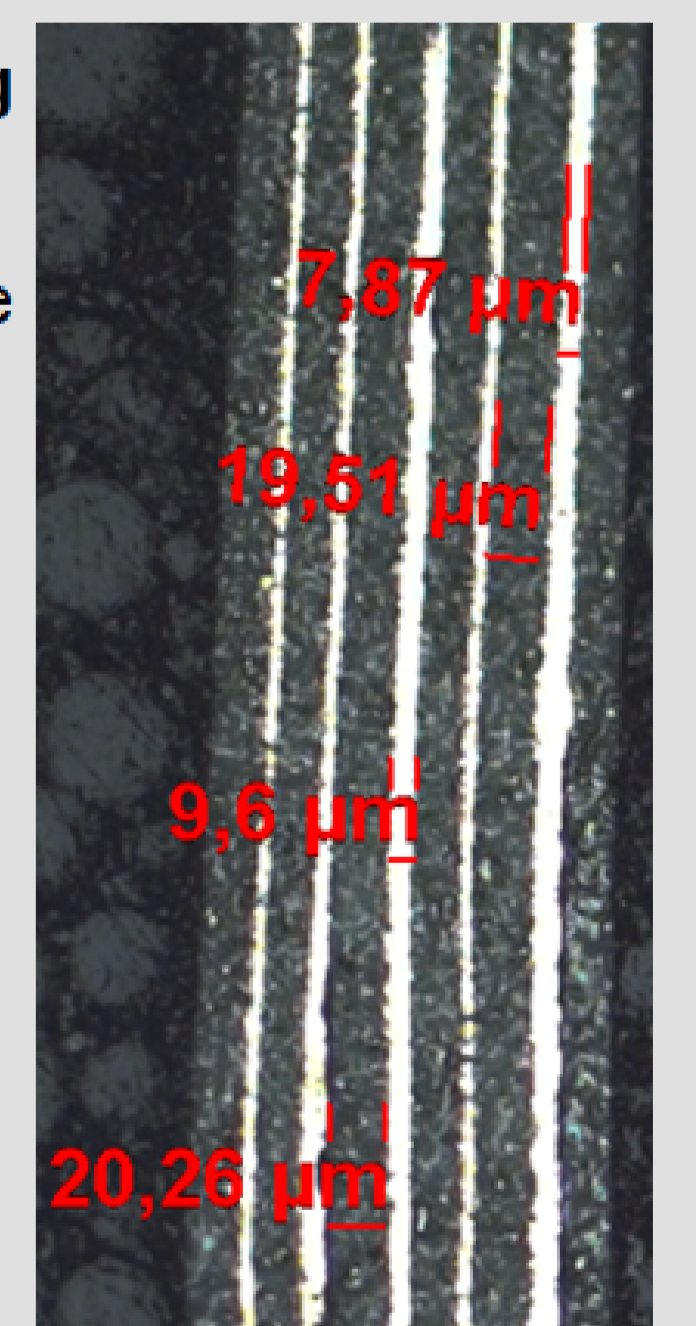


An alternating lateral shift Δx of the magnetically attracted mask leads to a small offset of every second electrode layer. After co-casting of several alternating layers this results in the desired interdigital electrode structure.

Conclusion

- The novel co-casting process simplifies the manufacturing process of piezoelectric multilayer devices with thin layers.
- The stacking and laminating of very thin and flexible ceramic green tapes is no longer necessary.
- Layers with thicknesses down to 20 μm can be realized.

layer state	ceramic layers [μm]			electrode layers [μm]	
wet	300	200	100	100	50
dried	120 \pm 10	83 \pm 7	40 \pm 5	55 \pm 3	28 \pm 2
fired	73 \pm 5	36 \pm 3	20 \pm 2	9 \pm 1	5 \pm 1



Piezoelectric triplelayer bending transducers with interdigital Ag electrode structure fabricated by casting both ceramic and metallic layers. After co-firing and applying outer electrodes, the MLs were poled in silicon oil. Wire bonding was made provisionally with conductive epoxide glue.

