Ferroelectric Thin Film Fabrication by Direct UV-Lithography

M. Benkler *, E. Grether *, J. Hobmaier *, J. Schott *, F. Paul *, T. Hanemann *,**

* Laboratory for Materials Processing, Department of Microsystems Engineering - IMTEK, University of Freiburg
** Material and Process Development, Institute for Applied Materials, Karlsruhe Institute of Technology

Motivation:

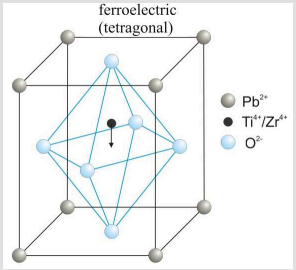
- ferroelectric films are widely used in the fields of sensors, actuators, capacitors and FRAMs
- currently used deposition methods need an additional patterning process step
- direct patterning of ceramic films by UV-lithography combines deposition and patterning
  → easy, cheap and cleanroom compatible alternative

Ferroelectric RAM (FRAM) devices (Fujitsu Semiconductor Europe)

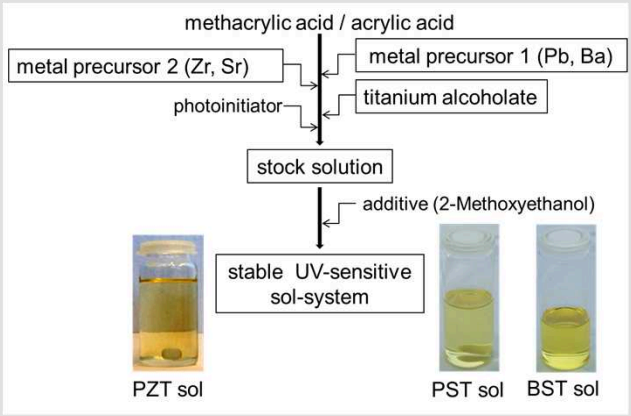
Used Materials:

ferroelectric ceramics with perovskite structure:

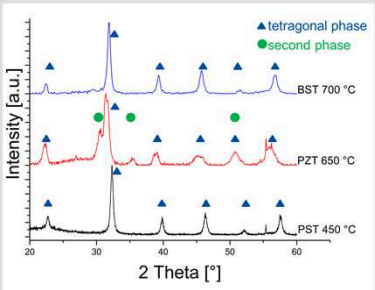
- lead zirconate titanate PZT ✓
- lead strontium titanate PST ✓
- barium strontium titanate BST ✓



Sol synthesis:



Phase analysis:

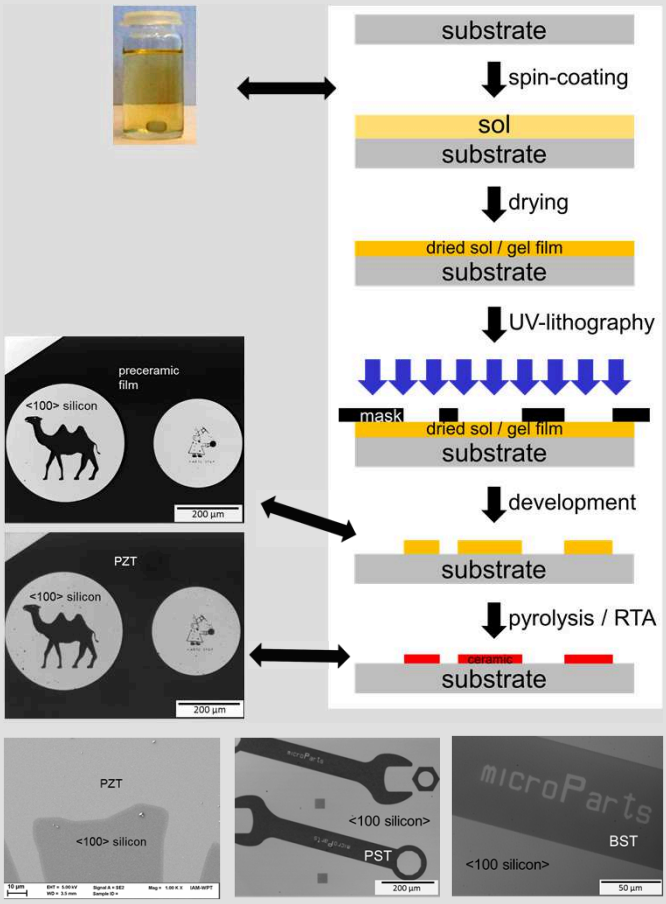


Formation of the desired ferroelectric tetragonal phase (perovskite) at pleasingly low temperatures:

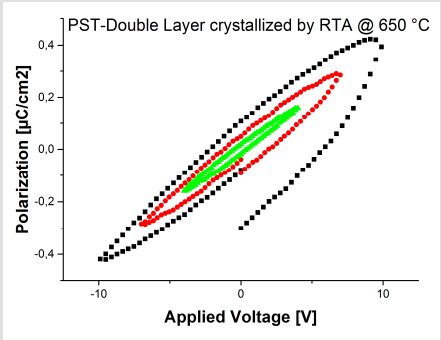
- PST ~ 450 °C
- PZT ~ 650 °C
- BST ~ 700 °C

Acknowledgement:
Financial support by the state of Baden-Württemberg,"Ministerium für Wissenschaft, Forschung und Kunst" within the graduate school "Generierungsmechanismen von Mikrostrukturen (GenMik)" is gratefully acknowledged.

Ceramic film generation:



Dielectric measurements:



Polarization vs. voltage shows hysteresis behavior

→ proof of ferroelectric properties of the ceramic films

Results:

- micro structured, crack free ceramic thin films
- low defect concentration
- polycrystalline and fine grained
- maximum lateral resolution 1-2 µm
- thickness 30-150 nm
- simple sol synthesis
- sols can be processed like commercial photoresists