Sols for Inkjet-Printing of tunable dielectric Barium-Strontium-Titanate films

*Department of Microsystems Engineering (IMTEK), University of Freiburg, Germany
** Karlsruhe Institute of Technology, (KIT),University of the State of Baden-Württemberg and National Research Center of the Helmholtz Association

Abstract

The ceramic system Ba_{1-x}Sr_xTiO_3 (BST) is the most promising candidate for the realization of electronically tunable devices in electrical engineering. For these applications it is important to implement the dielectric as a structured film. To directly deposit structured ceramic films, the drop-on-demand technology using liquid precursors is a promising method. Thin ceramic films consisting of BST were fabricated using inkjet-printing of preceramic sols.

System Ba_{1-x}Sr_xTiO_3 (BST)

Tetragonal, ferroelectric Cubic, paraelectric

Curie Point

Displacement of Ti^{4+}-ion by an external electrical field

- Almost no power consumption
- Tunability continuous
- Tunability speed in ns-range

Dielectric tunability

\[ \varepsilon(E) - \varepsilon(E=0) / \varepsilon_r(E=0) \]

Why generating thin films by Inkjet-printing?

Drop on Demand

- Non-contact processing of 2D and 3D structures
- Accurate droplet generation
- Low-cost and versatile method
- Printing of different materials

Printing System and Ink requirements

Printing system:

piezoelectric Drop-on-Demand (DoD) system

Microdrop - Autodrop Professional

Ink requirements

- constraints for surface tension and viscosity
- typical values:
  - \( \sigma = 10 \text{ - } 100 \text{ mN/m} \)
  - \( \eta = 5 \text{ - } 50 \text{ mPas} \)
- stable during printing

\[ W = \frac{\rho^2 \sigma a}{\gamma \eta} \]

Decrease of viscosity by

- Increase of the ceramic yield
- Increase of the temperature

Line stability

- Continuous line
- Stable liquid bead

Homogeneous film quality due to...

- ... minimization of printing frequency
- ... adequate speed of substrate
- ... an optimum of dot spacing