

1 *Example for lifetime test of capacitors*

## CAPACITORS AND DIELECTRICS

New materials for power electronic devices

### What we aim for

- Increase in energy density
- Reduction of volume
- Reduction of costs
- Improving thermal management

### Electrical characterization

- Impedance analysis of dielectric materials and capacitors and their dependence of frequency, temperature and (DC-Bias) - Voltage
- Measurement of leakage currents down to pA
- Measurement of breakdown voltage up to 20 kV

### Life-time test

- Climatic tests including high temperature reverse bias and high humidity high temperature reverse bias (HTRB, H3TRB)
- Passive temperature cycling tests

### Failure analyses

- Cross-section analysis and optical inspection
- Scanning electron microscopy and material analyses via EDX
- Lock-In-Thermography
- Focused ion beam preparation

#### Fraunhofer Institute for Integrated Systems and Device Technology IISB

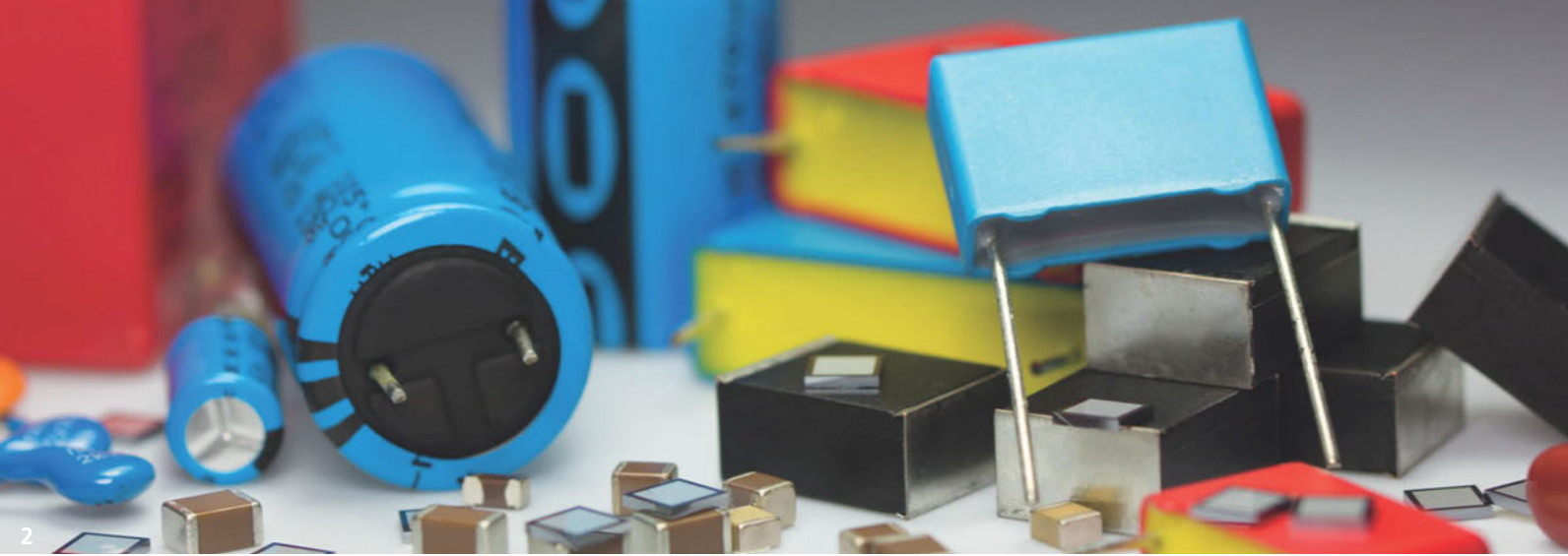
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### Thin glass

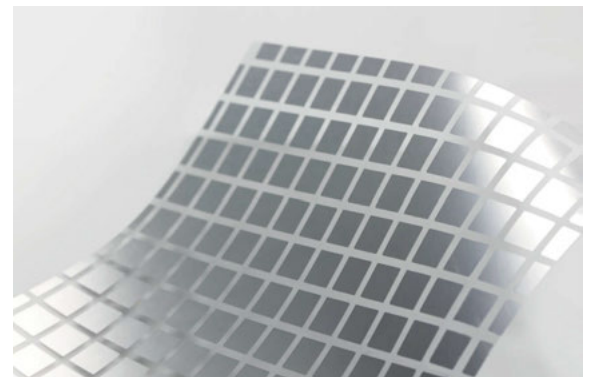
- Novel dielectric material for high voltage applications
- Dielectric constant of  $\epsilon_r = 5.1$
- Breakdown field strength of 590 kV/mm @ 25 $\mu$ m
- Low dependence of temperature, frequency and DC-Bias
- High energy density
- Flexible glass makes roll-to-roll-processes possible

### Silicon integrated capacitor

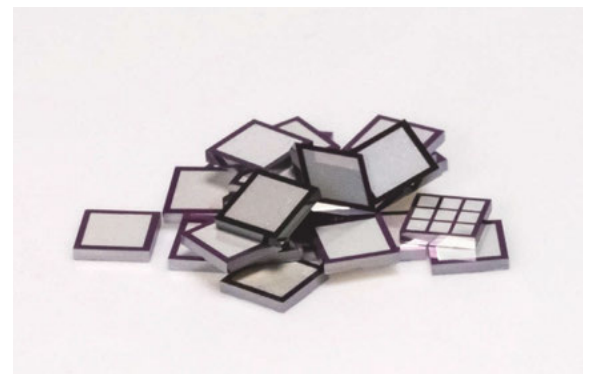
- Pick and place like standard IGBT or diode
- Low parasitic inductance compared to discrete solutions
- High thermal conductivity of silicon substrate with low thermal impedance
- High resonant frequency
- Excellent temperature behaviour of the trench capacitor. ( $\Delta C < 100\text{ppm/K}$ )
- No piezoelectric effect
- No electrostatic-sensitive device
- Available for 200 V up to 600 V applications
- Ready for production @ IISB

### Ceramic

- New ceramic material with high dielectric constant (in cooperation with research partners)
- High dielectric constant  $\epsilon_r > 3500$
- Breakdown voltage of 500 V
- High temperature applications



*Thin Glass: New dielectric material with high operating temperature capability*



*Silicon bare die capacitors: Best suited as snubber device for pick and place*



*Ceramic: New materials appear on the horizon*