Kompetenzplattform Polymere Materialien

Hochschule Bonn-Rhein-Sieg

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VOCO Your Specialist for Dental Materials

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Dielectric Analysis of Short-Term and Long-Term Curing of Novel Photo-Curing Dental Filling Materials

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Overview:

- Introduction
- Methods and materials
  - DEA (Dielectrical Analysis)

  In comparison to DEA:
  - DSC (Differential Scanning Calorimetry)
  - DMA (Dynamic Mechanical Analysis)
- Results
- Conclusion

Introduction

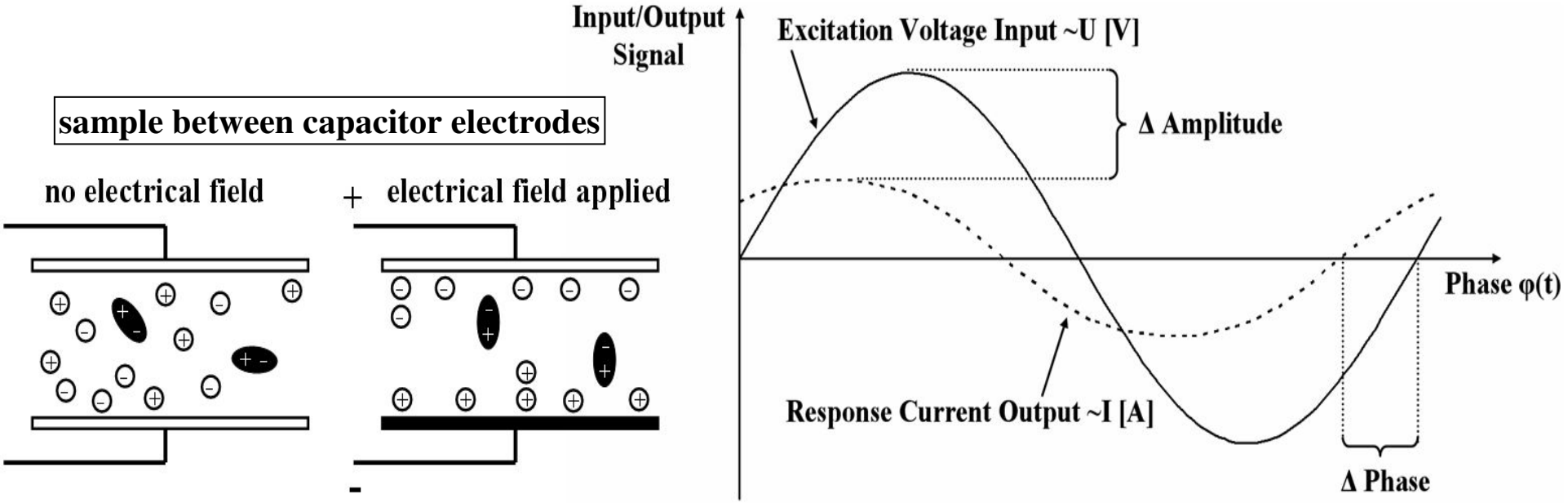
- **Scope:**
  - **Better understanding of the reaction kinetics of composite dental fillings**
  - **Adaption of thermal analysis methods (e.g. DEA, DSC and DMA)**
- **Performed methods of investigation of the curing process of dental composites:**
  - **DEA (Dielectrical Analysis)**
    measurement of the time-dependent ion viscosity
  - **results are compared with**
    - **DSC (Differential Scanning Calorimetry)**
      calorimetric measurement of the reaction enthalpy
    - **DMA (Dynamic Mechanical Analysis)**
      mechanical measurement of the stiffness increase
- **Materials:**
  - **VOCO, ARABESK TOP®-product series**

Application example:

- **Dental filling with photo-cured composite material**

- **DEA** (Dielectrical Analysis)**:**

  Measuring principle of the applied DEA sensor



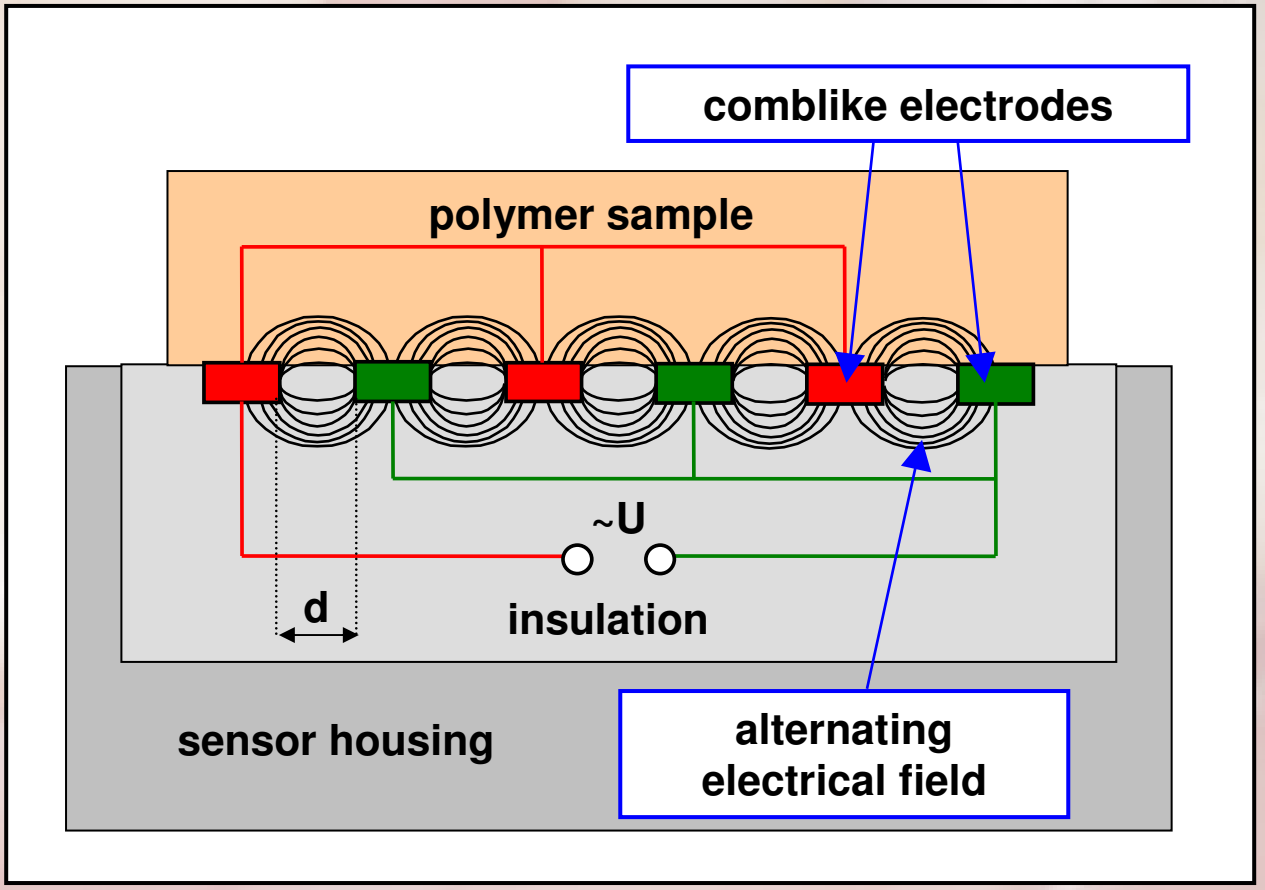
Measuring quantities:

- ion viscosity μ
- dielectrical loss ε‘‘
- dielectrical constant ε

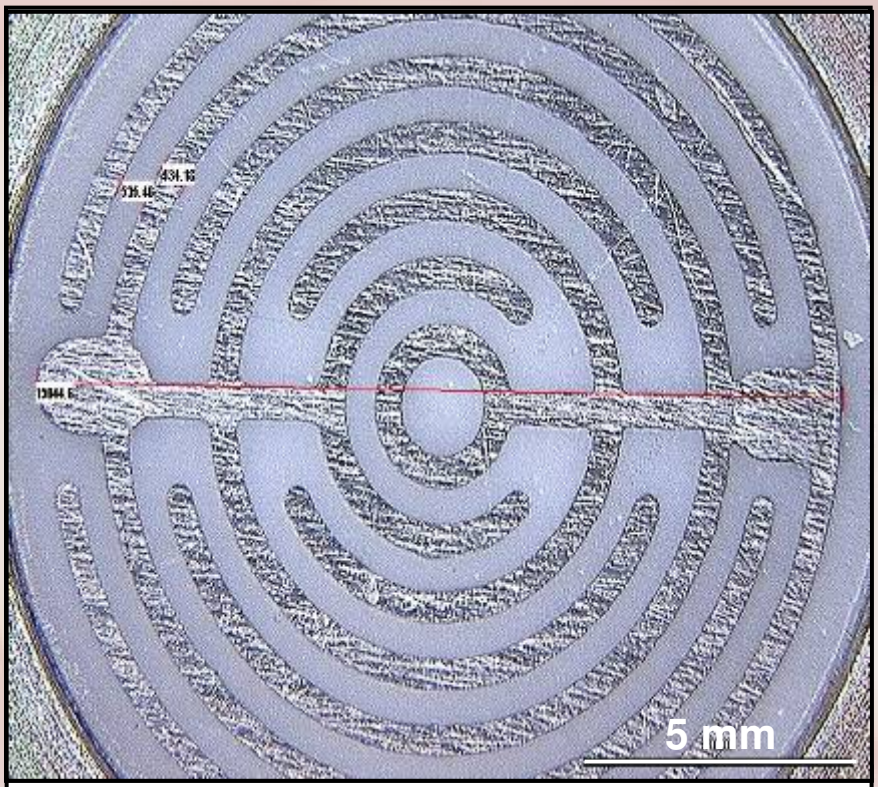
- **DEA** (Dielectrical Analysis)**:**

Measuring principle of the applied DEA sensor

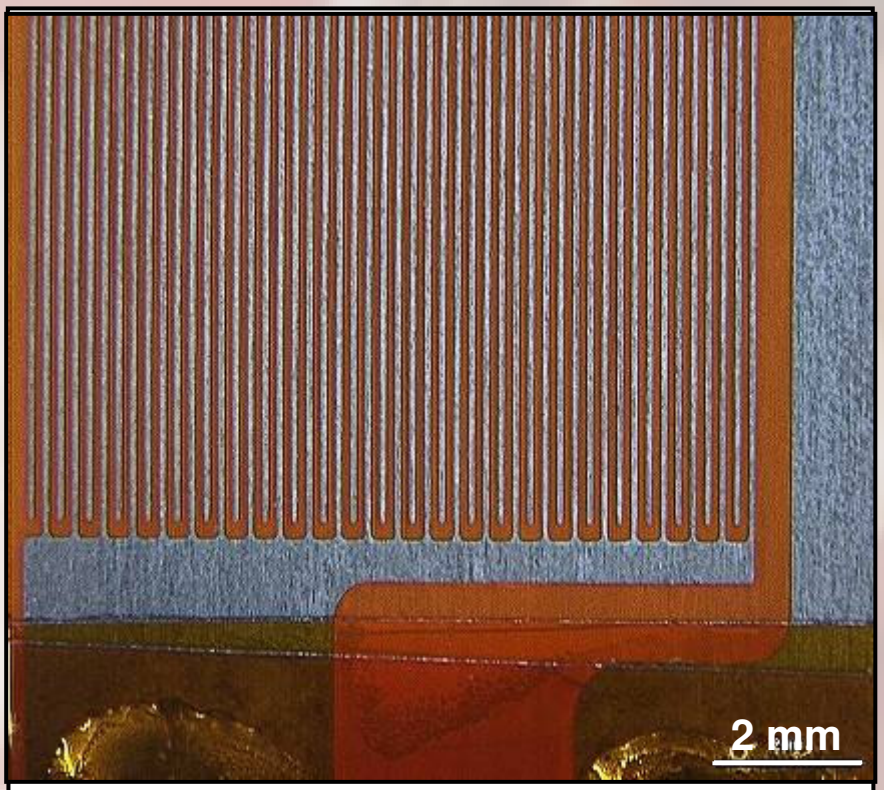
(different capacitor arrangement due to illumination of the sample)



- **DEA** (Dielectrical Analysis)**: sensor surfaces**



NETZSCH® TMS sensor
(Tool Mount Sensor; 1mm electrode distance)



NETZSCH® IDEX sensor
(interdigitated electrode; 115 µm electrode distance)

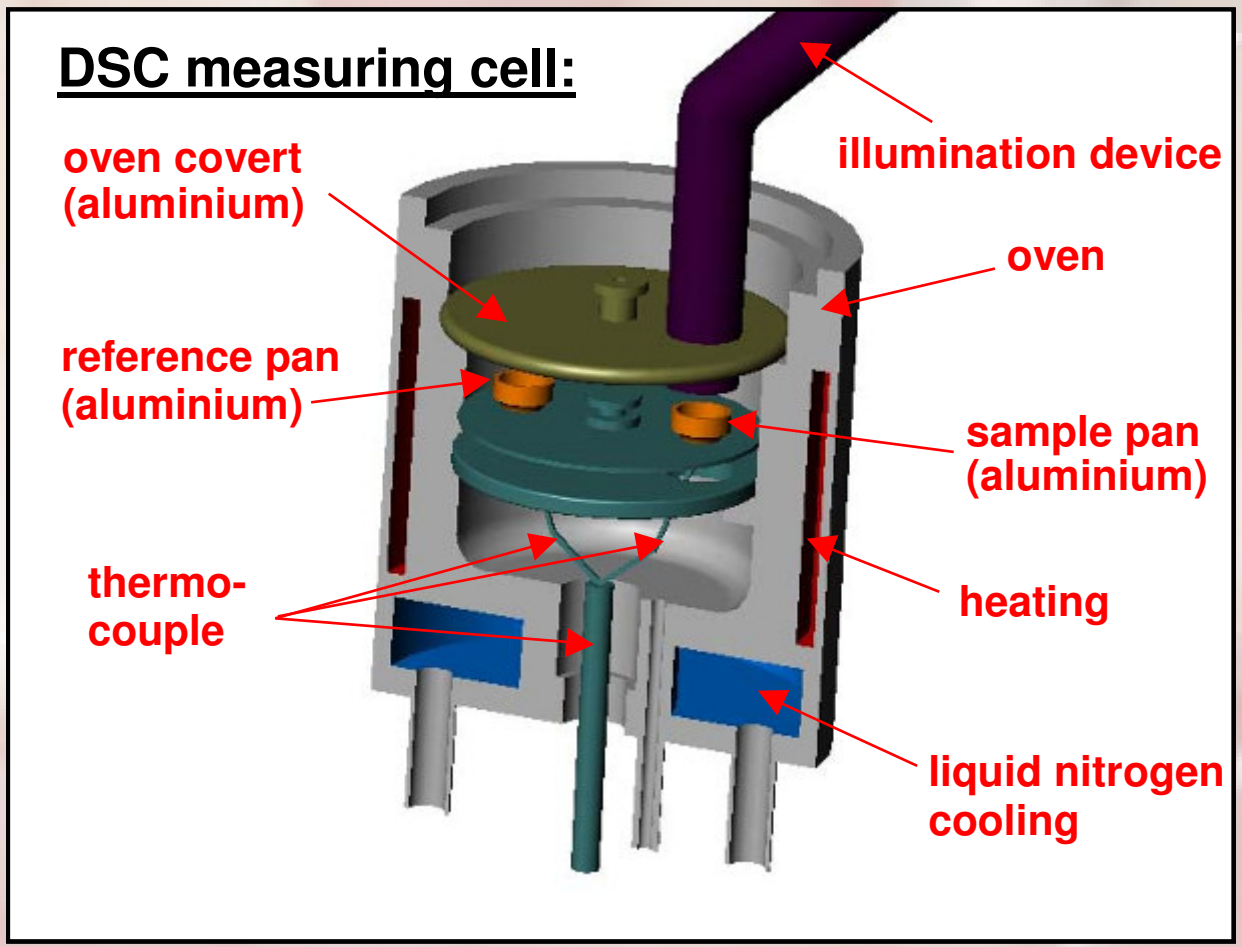
- **DEA** (Dielectrical Analysis)**: experimental set-up**

DEA experimental set-up investigation of primary-curing

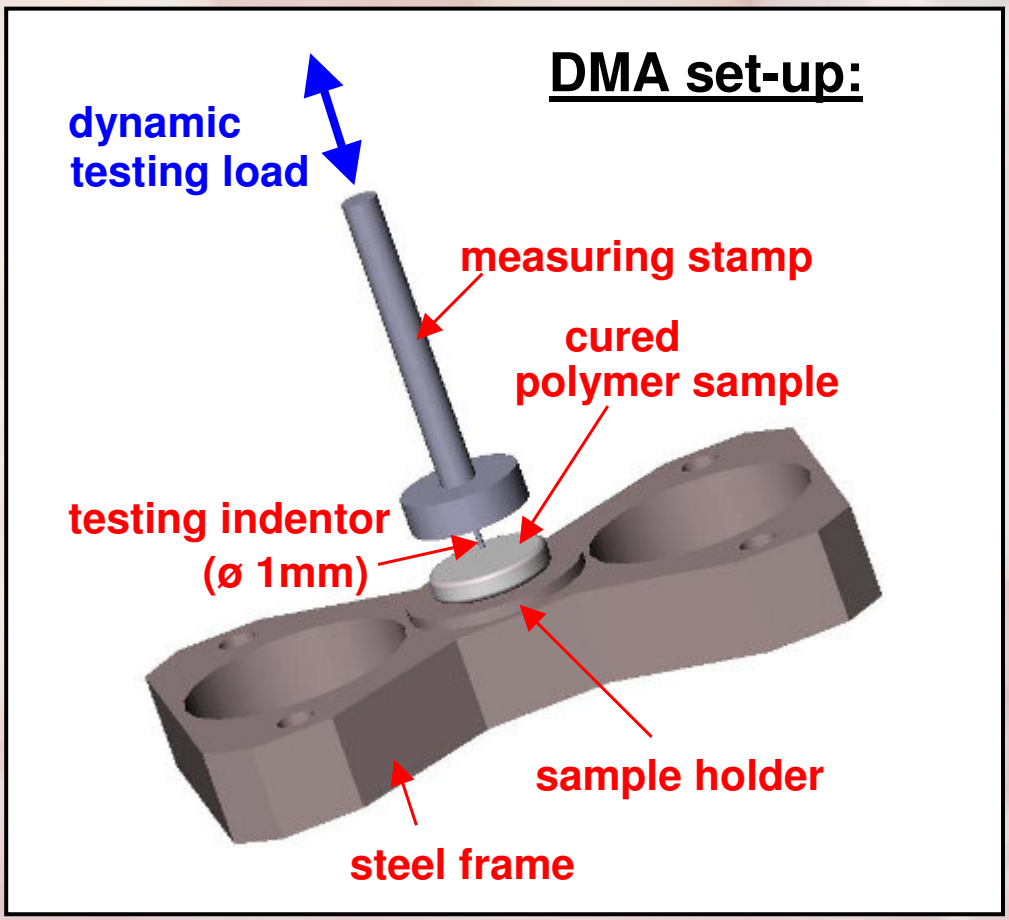
DEA experimental set-up investigation of post curing 36 °C

- **DSC** (Differential Scanning Calorimetry)**:**

Measuring principle of the applied modified DSC device

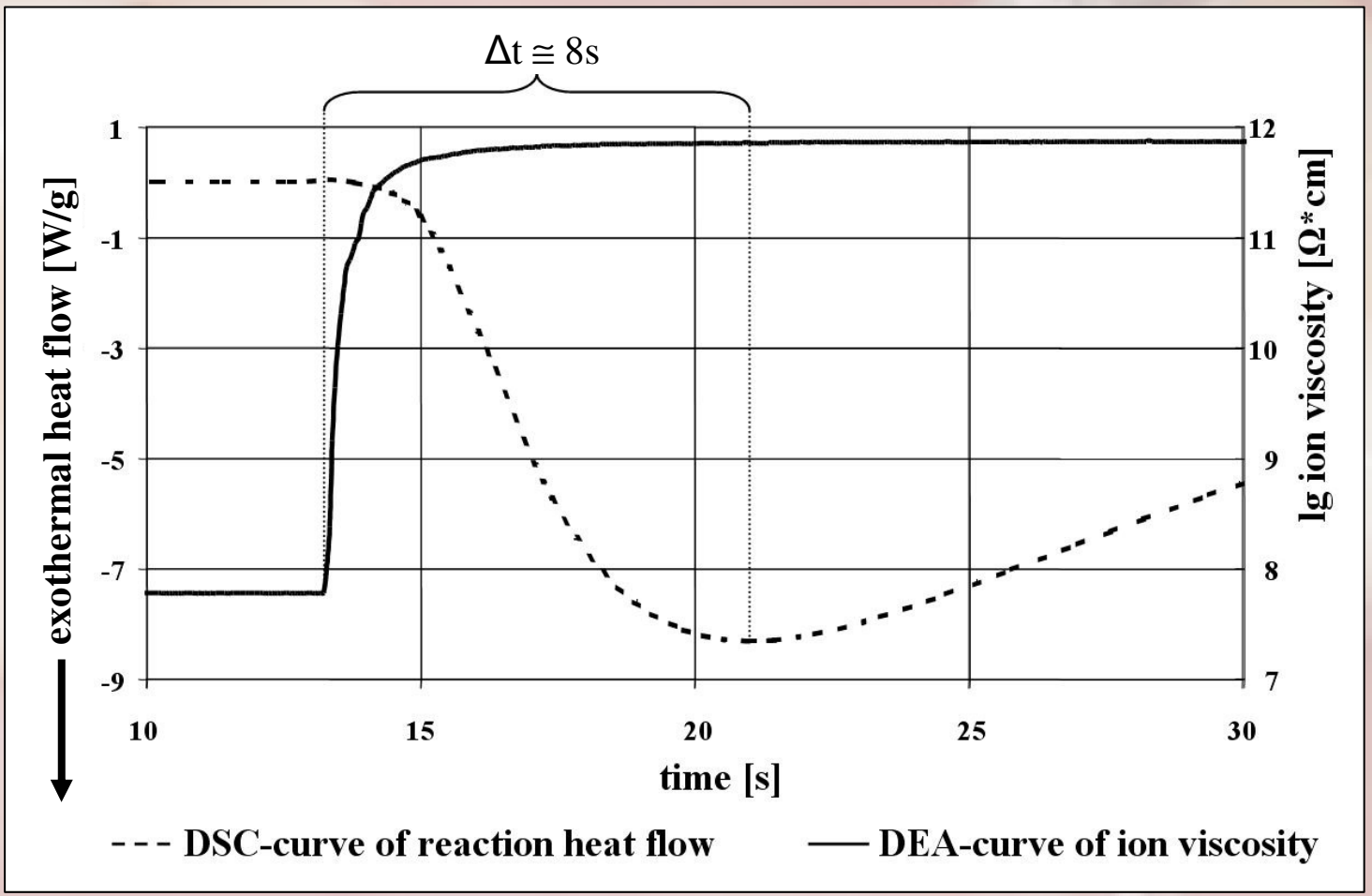


- **DMA** (Dynamic Mechanical Analysis)**:**
  Measuring principle of the applied modified DMA device
  (similar to a hardness test)



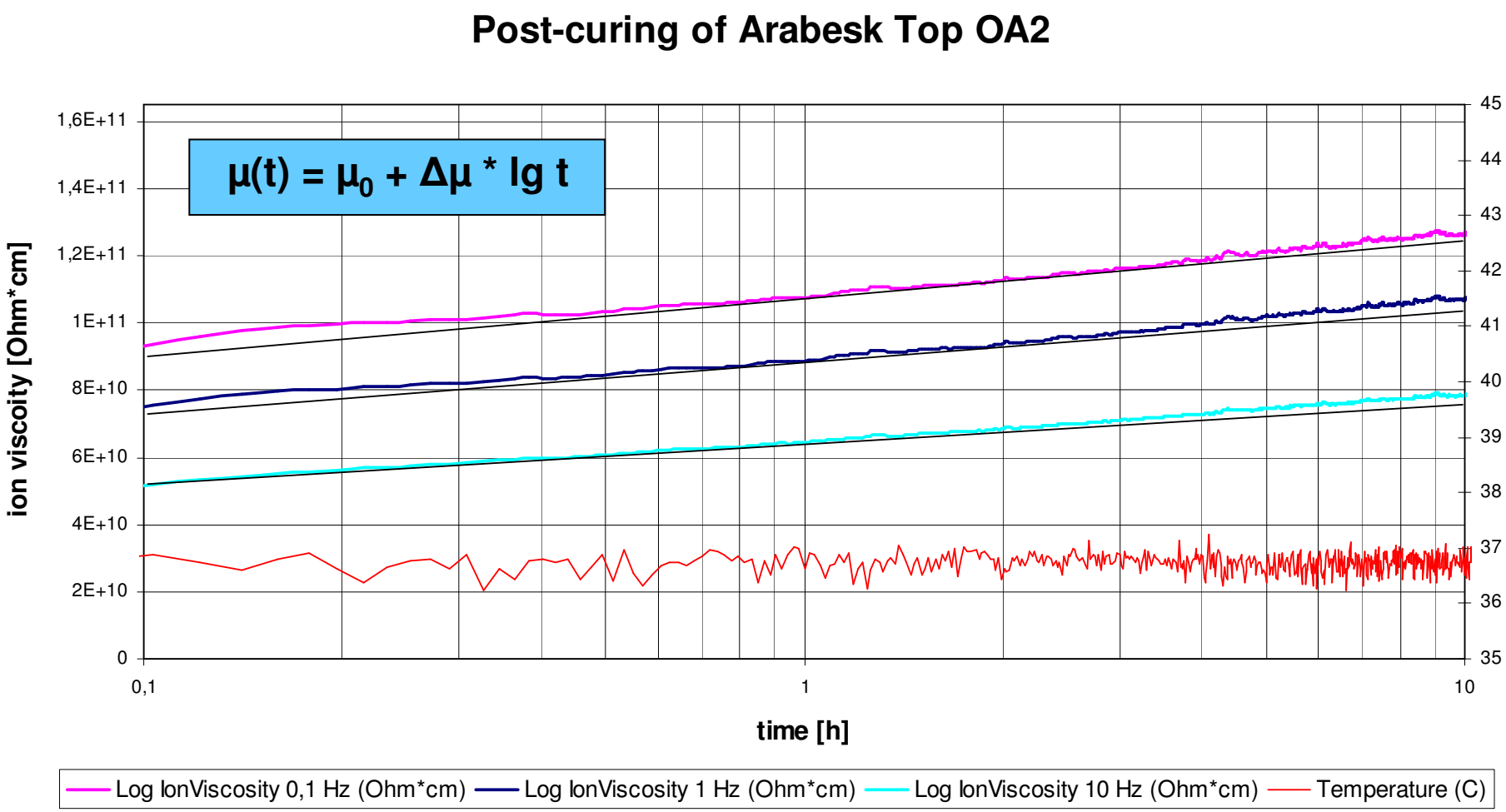
Results of the light induced curing

- **DEA** (Dielectrical Analysis) versus **DSC** (Differential Scanning Calorimetry)



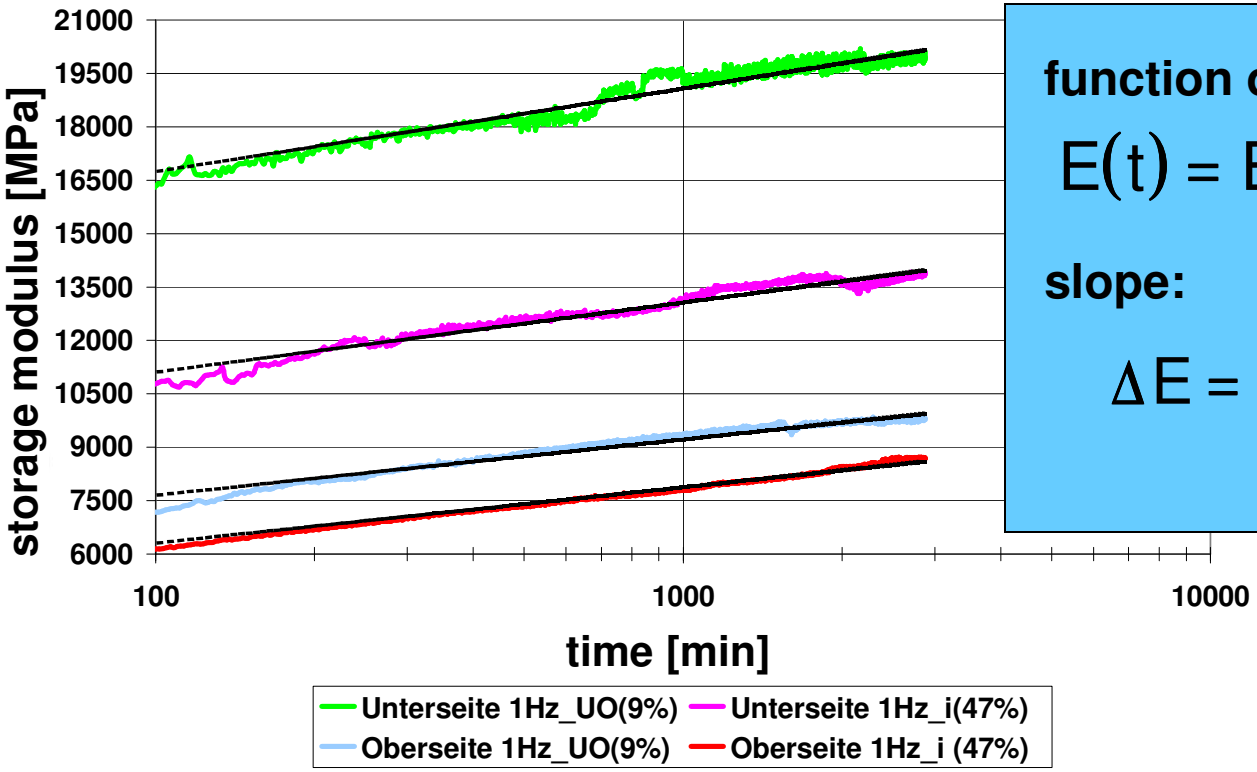
Results of the post-curing

- **DEA** (Dielectric Analysis)**: logarithmic time scale**



Evaluation of the post-curing

- **DMA** (Dynamic Mechanical Analysis)**: logarithmic time scale**



function of elastic modulus:

$$E(t) = E_0 + [\Delta E \cdot \lg(t)]$$

slope:

$$\Delta E = \frac{(E_2 - E_1)}{[\lg(t_2) - \lg(t_1)]}$$

post-curing behavior of ARABESK TOP® I and UO
(measurement of 2mm thick samples over 48 h on the upper light exposed and on the back side)

conclusion

- **Most of the primary curing of the dental composites happens within the first 7-10s of illumination**
- **post-curing processes depend logarithmically on time**
- **DEA, DSC and DMA are appropriate methods to analyse the reaction kinetics of such dental composites**

Benefits in the future:

- **precise studies of the curing kinetics of dental filling materials are possible**
  - **→ kinetic models can be developed**
  - **→ illumination strategies can be varified**
- **material development cycles can be shortened**

Thank you very much for your attention!