

Simultaneous electrophoretic deposition of polymerferroelectric ceramic-composites

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Summary

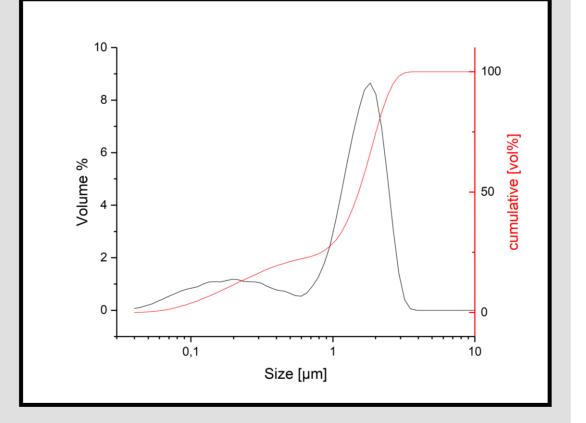
- EPD is a versatile process for producing polymerceramic composites.
- Adjustable layer thickness and polymer content
- Posibility to get substrate-free, sintered ceramic plates

Experimental Setup Polymer component: Ceramic component: Isopropanol : Acetone PMMA (MW:15000) Barium titanate **Process Parameters** 60 - 120 ml volume Dissolving of PMMA Deagglomeration: Ultrasound 12 -20min ultrasound Substrate: Nickel coated steel / Graphite **Electrophoretic depostion** Voltage: 50 - 150 V 6 to 150 seconds Deposited mass Thickness of the layer Characterisation Polymer content Relative permitivity

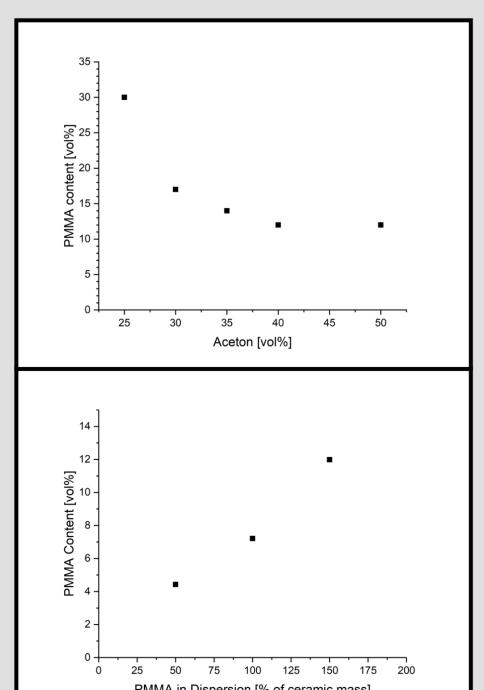
Fig. 1: Process chain to deposit composite materials via EPD

- Layerthickness ranging from 20 to 200 µm can be achieved
- Fast processing speed

Fig. 2: Typical particle size distribution in the dispersion used for the EPD. Tests have shown that TODA is a suitable dispersant for this system.



Depositing Composites



- Polymer-Ceramic composites can be depositet simultaniosly
- Polymer content can be adjusted in a wide range
- Layerthickness ranging from 20 to 200 µm can be achieved
- Fast processing speed

Fig. 3: PMMA content in the composite in relation to the solvent mixture (upper Graph) and the PMMA content in the dispersion (lower graph)

Fig 4: 1) Measurement of the layer thickness and image of the surface roughness 2) Sample with a silver electrode for dielectric characterisation 3) Embedded Sample for thickness

- Surface roughness of about 5 µm and less
- Porous layers
- Irregularity on the edge of the samples

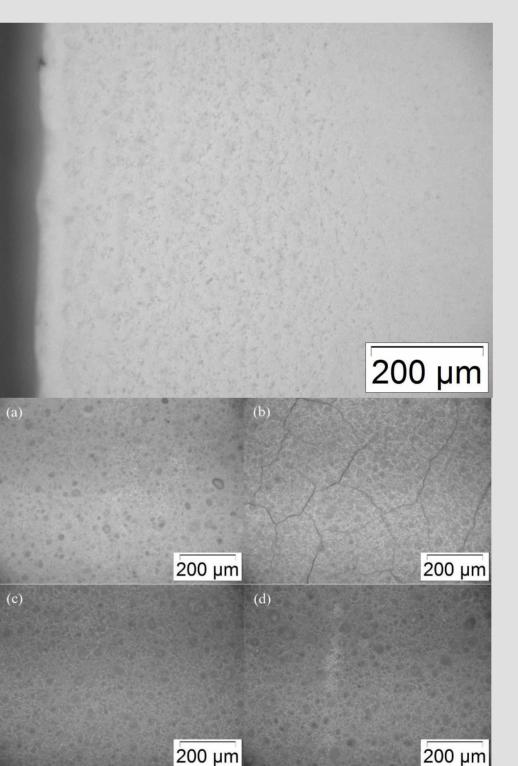


Fig. 5: Microscopic image of the edge of a sample. The experiment showed that there are some irregularities at the edge, there the electric field is not as linear as it is in the middle between the electrodes.

Fig. 6: Microscopic images of KNN composite layers with a ten times magnification. From a to d in different time intervals between suspension preparation and deposition (1,14,29,37 min). (a) and (b) had a deposition time of 40 while (c) and (d) only had 25 s. It seems there is a slight agglomeration in this timeframe which was beneficial in this case for the layer quality and deposition speed.

Substrate free Layers



Fig. 7: from left to right: Ceramic composite layer on graphite substrate, layer after debinding and sintering, debinding (red) and sintering (blue) temperature programm

- Long and two step process at the moment
- Brittle but nearly dense ceramics

