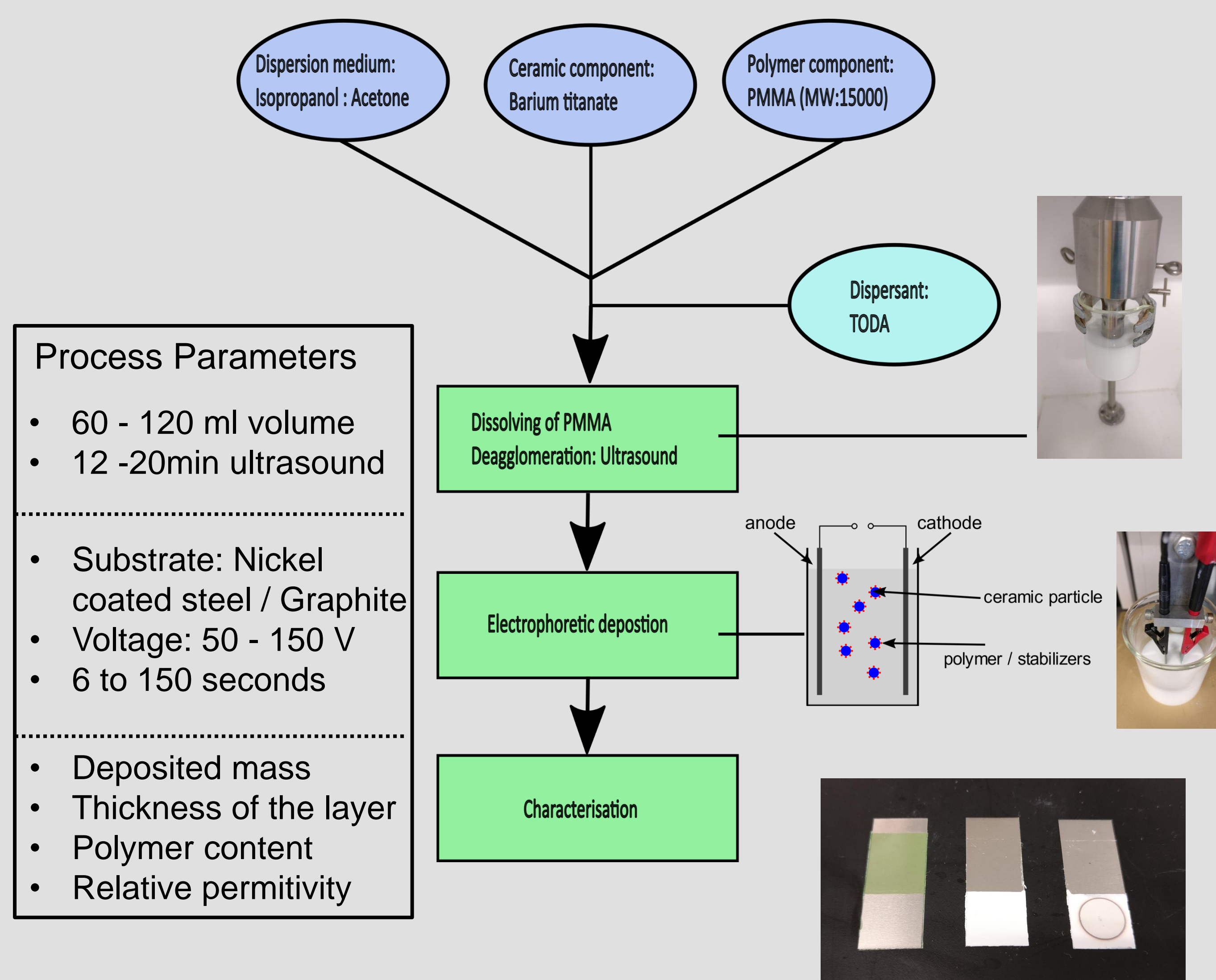


## Summary

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

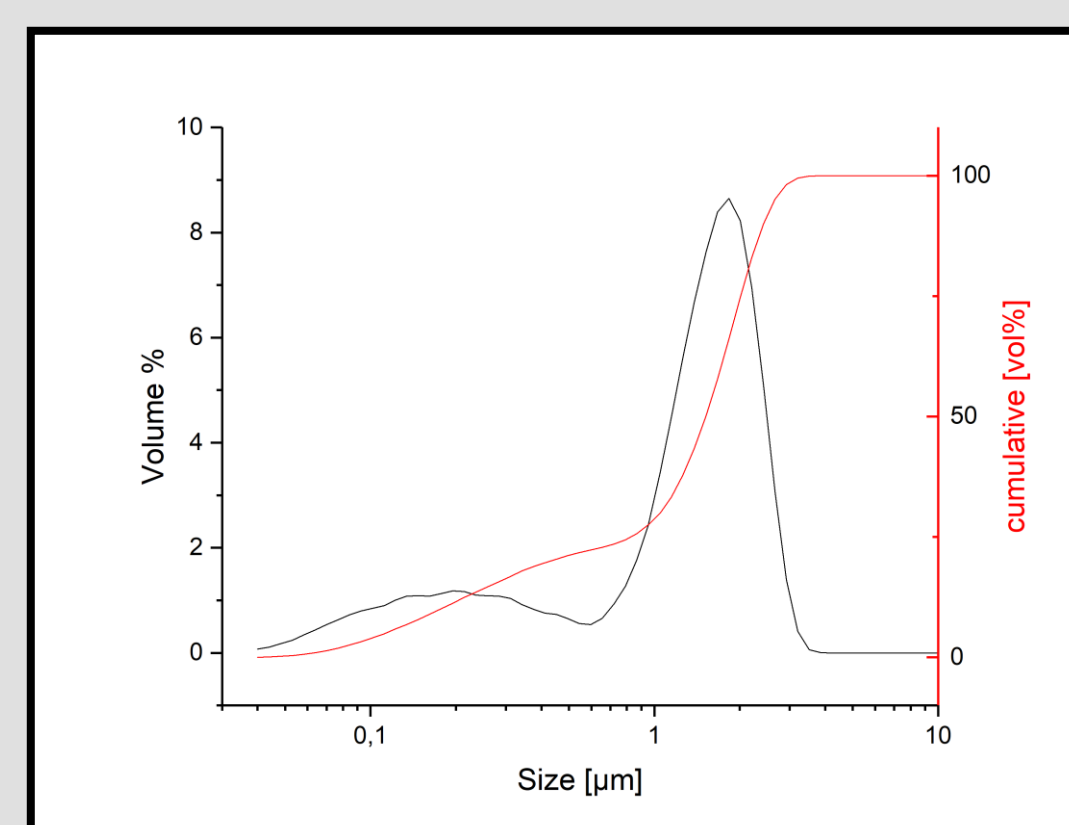
## Experimental Setup



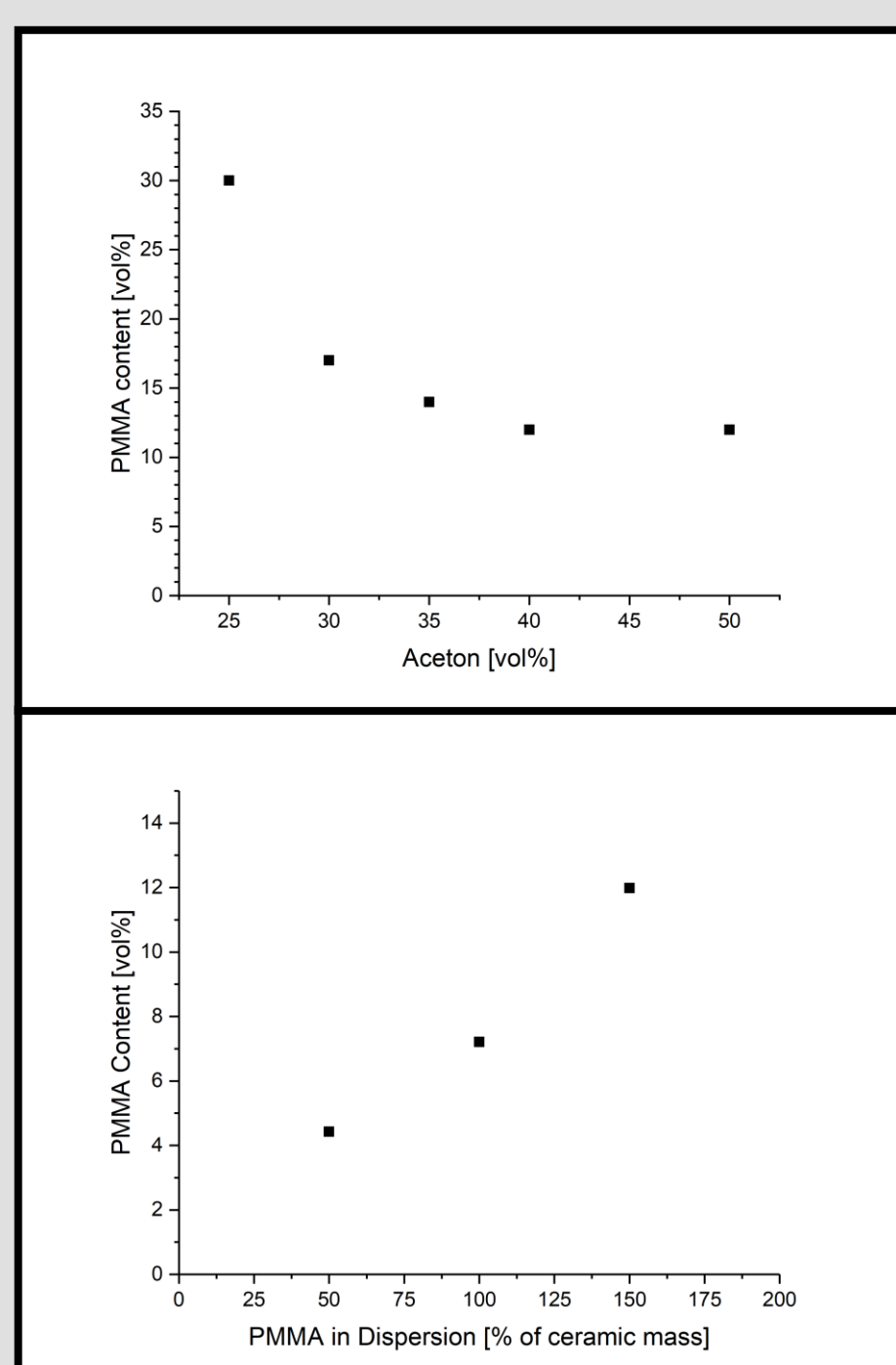
**Fig. 1:** Process chain to deposit composite materials via EPD

- Layerthickness ranging from 20 to 200  $\mu\text{m}$  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.



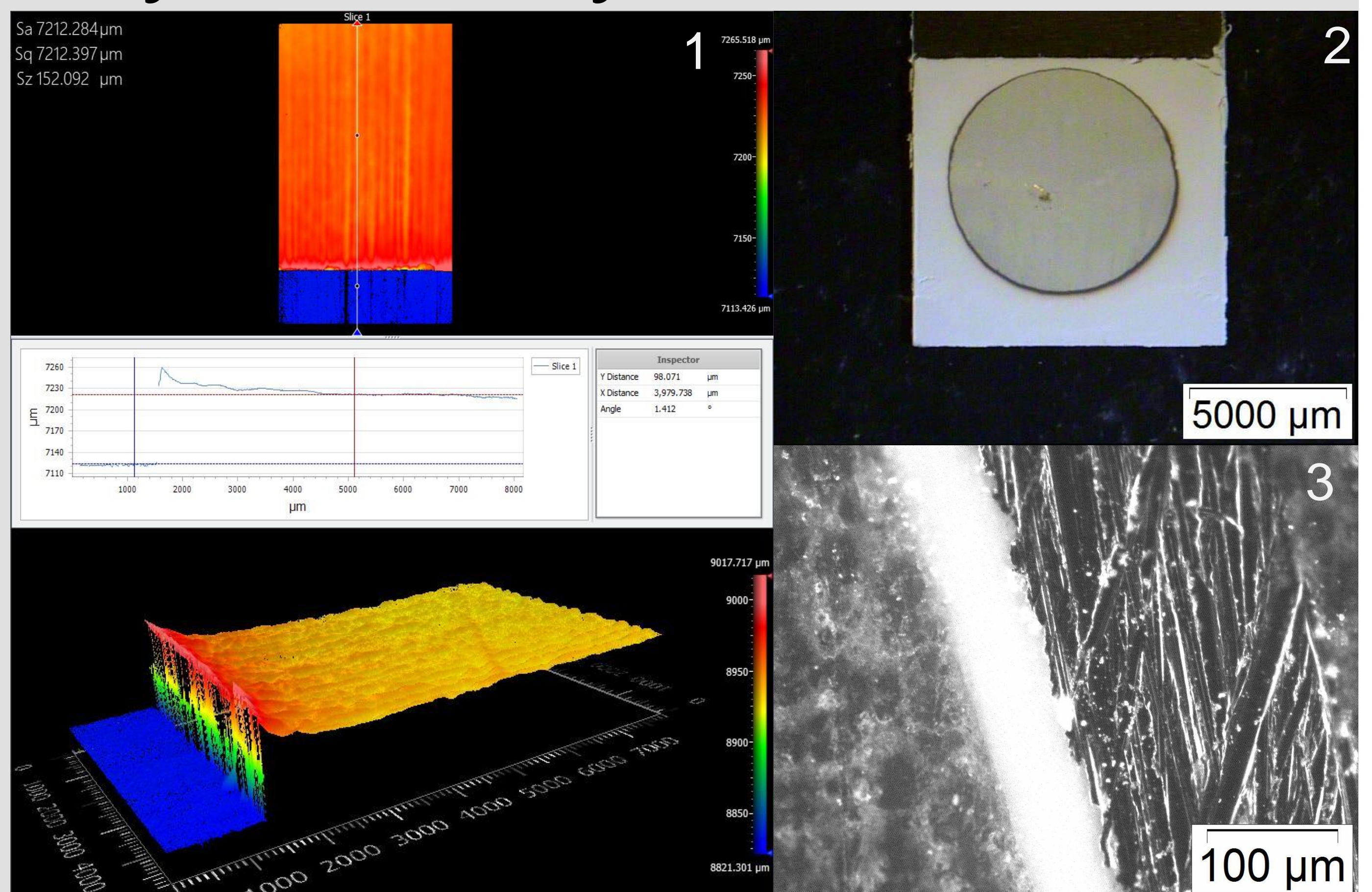
## Depositing Composites



- Polymer-Ceramic composites can be deposited simultaneously
- Polymer content can be adjusted in a wide range
- Layerthickness ranging from 20 to 200  $\mu\text{m}$  can be achieved
- Fast processing speed

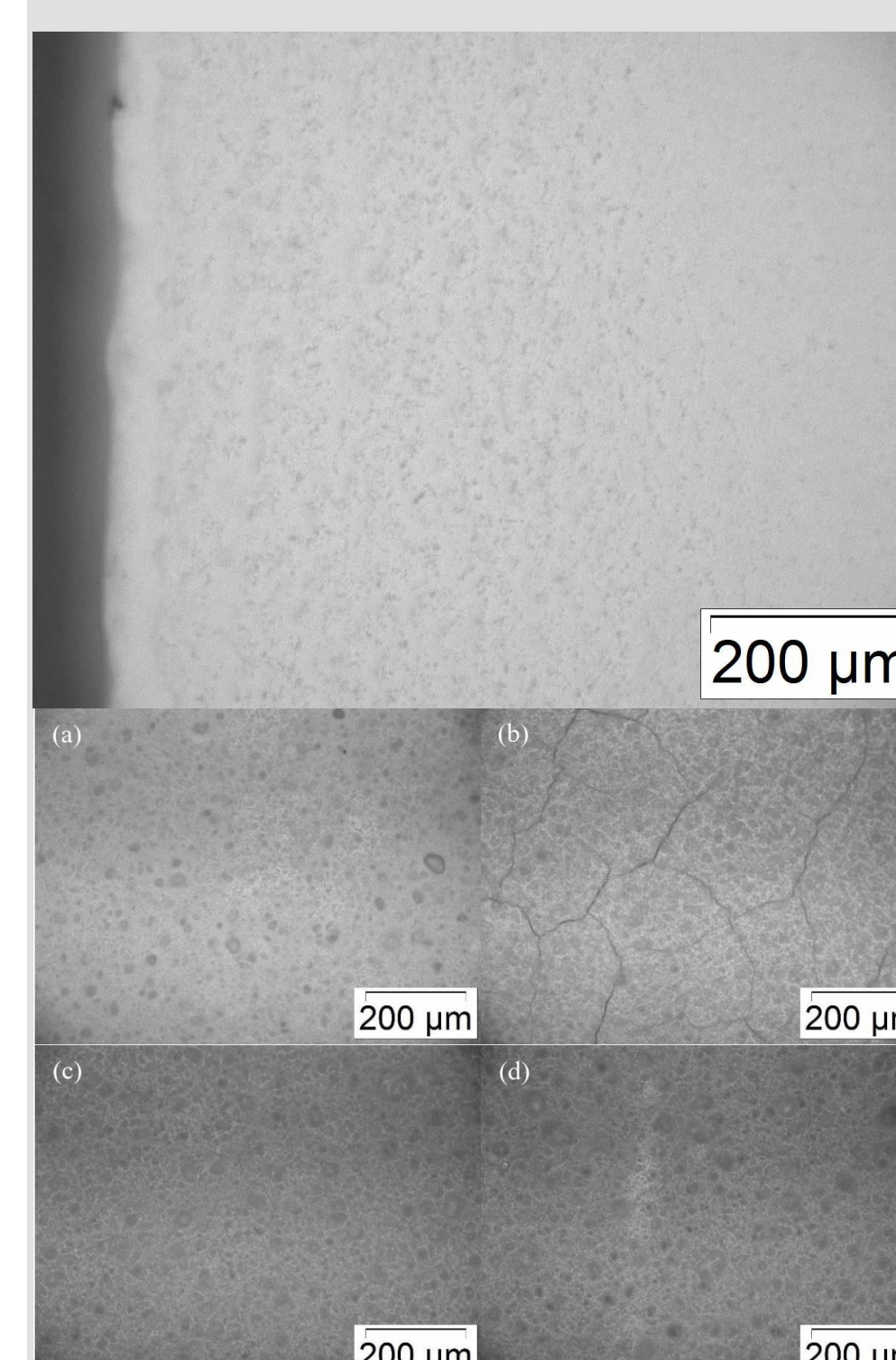
**Fig. 3:** PMMA content in the composite in relation to the solvent mixture (upper Graph) and the PMMA content in the dispersion (lower graph)

## Layer Quality

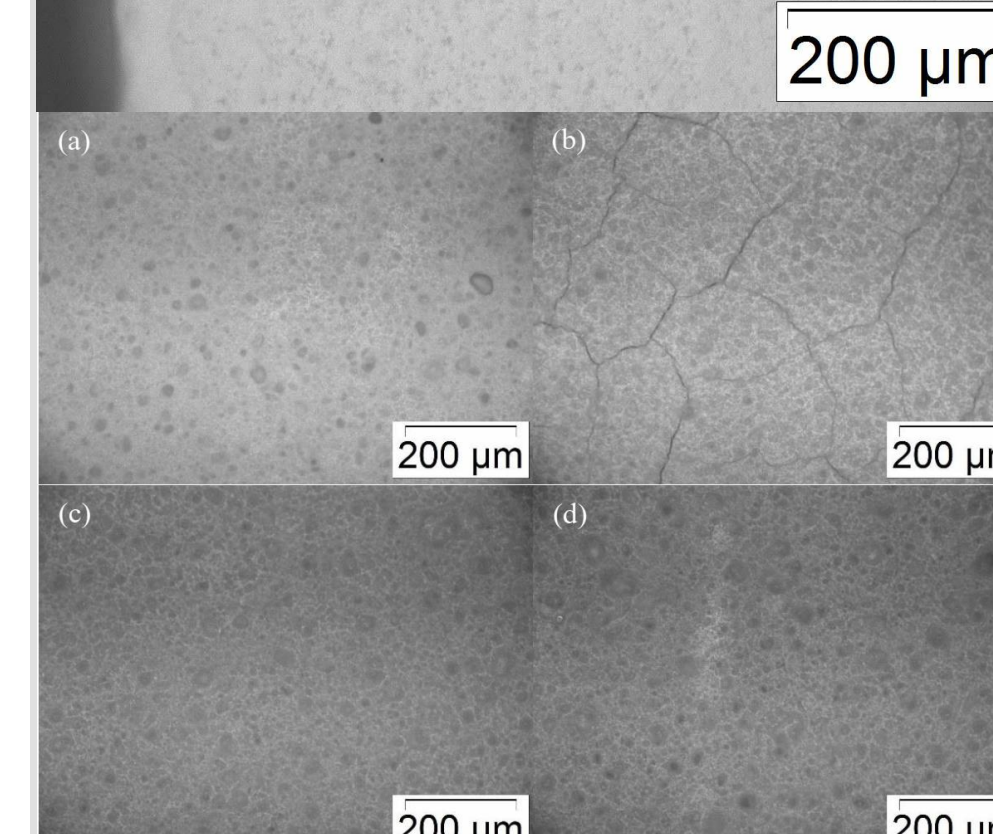


**Fig 4:** 1) Measurement of the layer thickness and image of the surface roughness 2) Sample with a silver electrode for dielectric characterisation 3) Embedded Sample for thickness

- Surface roughness of about 5  $\mu\text{m}$  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



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