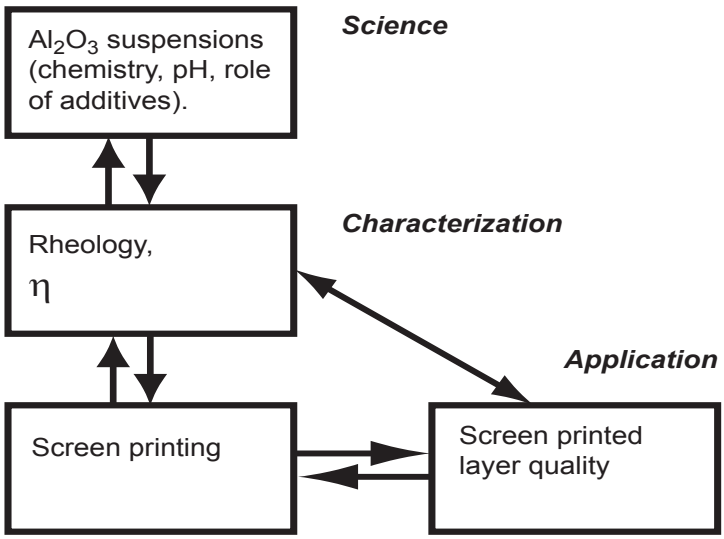
Surface Structuring (Oberflächenstrukturierung)

(As this course will occasionally be held in English by Mr. Chen, we decided to do this manual in English as well)

Introduction



The aim of the Surface Structuring experiments is to get a feeling how science - in this case the science of ceramic colloidal suspensions - and application relate to each other. Linking is done by 'characterising', a non-specific expression by which usually a series of measurement experiments are meant. Sheer numbers derived from the characterisation experiments are of little value. They have to be interpreted in terms of both basic understanding of the chemical and physical processes that are going on inside the samples and in terms of suitability for the application in mind. Ideally, once we understand the science behind measurements and have identified the properties needed for the application, we have a tool to optimize or even predict the best processing conditions. And that will be your goal. Concretely, we are going to examine the system colloidal chemistry of alumina suspensions (science), its rheology (characterization method) and applicability to screen-printing.

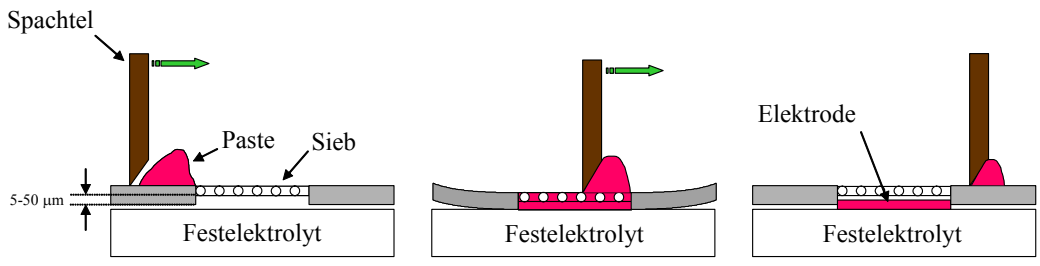


Figure 2. Screen printing.
Screen-printing is one of the most important technologies to apply ceramic pastes onto a wide variety of surfaces. The whole layer including a well defined lateral shape is deposited in just one step, which makes the process very economical. The process is illustrated in Fig. 2. A ceramic paste is transferred through a finely meshed fabric that is brought into contact with the substrate. According to the desired shape certain meshes are closed so the substrate remains uncoated at those locations. An arbitrary design can be transferred this way. The transfer process itself is done by wiping the suspension across the whole fabric. The technology is mature and is widely used by many industries. Not only ceramic coatings are screen-printed, another important application is printing of colors onto textiles.

Theory

All the theory necessary to the experiments is treated in chapter 7 (partially 8) of the transscript 'Ingenieurkeramik 2'.
We expect you to have read through and understood most of it and to have it nearby for consultation.

Experiments

1. Preparation of Suspensions:

4 suspensions at different pH values according to the following procedures are to be prepared. General procedure: First dissolve all the additives in the required amount of water in a suitable beaker. Then set it up for stirring. Weigh the appropriate amount of alumina powder and add it slowly and portionwise under stirring. Check pH occasionally. Leave to stir for another 5 min and transfer the suspension into a plastic flask containing ceramic milling balls (1/3 of flask volume approx.). Leave on rotating ball mill for at least 2 hrs.

Note your observations during preparation !

Quantities:

Resulting pH about 4:
100 g of alumina
29.5g water
1.15g HCl (2N)

Resulting pH about 6:
100 g of alumina
30.1 g water
0.53 g HCl (2N)

Resulting pH about 9:
100 g of alumina
30.5 g water
0.13 g HCl (2N)

The suspension with pH about 9, modified with diammonium citrate :
100 g of alumina
30.2 g water
0.45 g diammonium citrate

2. Rheology
Viscosity curves will be recorded on our Bohlin Rheometer. Lena ?

3. Screen printing
Screen printing will be carried out on glass slides (Objekträger). They are mounted onto an aligner in a way that the mesh can be brought into close contact. A few droplets are then distributed on the mesh surface and transferred by wiping **once** across the structures. The mesh then is lifted.

IMPORTANT: Immediately rinse with pure water, then ethanol in order to keep the pores of the mesh open. Suspension remainders must not dry !

4. Characterisation of Screen-Printed Layers
Assess the quality of the structured green body layers by taking microscope images, e.g. 1-2 images per sample. Use the images to point out your interpretation later on.

5. Before writing the report
The data you now have should consist of:
- suspensions at different pH
- actual pH values
- viscosity and shear stress (‘Schubspannung’) curves for each suspension
- 1-2 screen printed glass slides per suspension
- lots of images of the screen-printed samples

Get together and discuss your results relating to the process scheme in Figure 1. Fill in meaningful relations between alumina suspension chemistry, the measurements and the resulting surface pattern quality. In the discussion of your report, find answers to the following questions and add your own conclusions:

- Which suspension is best suited for the application and why?
- Which one is worst, why?
- What does the corresponding rheology look like?
- Imagine you were given another powder, say titanium oxide, to develop a suspension suited for screen-printing. What would your procedure be to find a good recipe?