Ceramic Lab Course (04-26-KE-006)

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http://www.ceramics.uni-bremen.de

➢ Outline: Lab experiments

- **Experiment 1: Stability of ceramic suspensions and particle size determination**
  (T. Guo, IW3 2290, ☎ -64965, tguo@uni-bremen.de)

- **Experiment 2: Flow behavior of ceramic suspensions**
  (M. Maas, IW3 2140, ☎ -64939, michael.maas@uni-bremen.de)

- **Experiment 3: Determination of density in porous ceramic materials**
  (P. Braun & T. Kühn, IW3 2220 & 2150, ☎ -64963 & -64936, pedrohe1@uni-bremen.de & tkuehn@uni-bremen.de)

- **Experiment 4: Strength and fracture toughness of ceramic materials**
  (R. Almeida, IW3 2240, ☎ -64946, renato.almeida@uni-bremen.de)

➢ What do you have to do to take part in the lab course?

Send an e-mail with the following information to:
renato.almeida@uni-bremen.de

Last name	First name	Study programme	Matriculation no.	Free time slots
Student	Example	B.Sc. PT	1234567	Tuesdays from 2pm, wednesdays until 12 pm

Additionally register in Stud-IP (https://elearning.uni-bremen.de/)
for the course Keramiklabor (04-26-KE-006)

Groups (3-4 persons) will be set-up according to the available time slots.
If you are a group of 3-4 persons you can also register as a group with all the necessary information (see above).

Registration is open now until 01.05 / 20.11!

➢ Organization/grading and script

SCRIPT! (German and English version)

Download via:

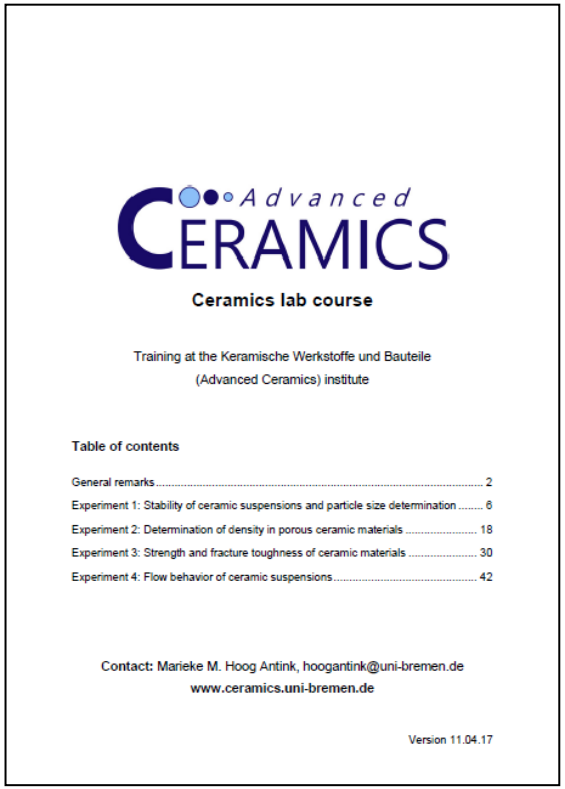
http://www.ceramics.uni-bremen.de/Academic/SS/Keramiklabor/Keramiklabor.html

Password: **„ceramics“**

Provides information concerning:

- Grading
- Requirements
- Report creation
- Contents of the lab course
- …

→ **Should be read thoroughly!**



Advanced CERAMICS

Ceramics lab course

Training at the Keramische Werkstoffe und Bauteile
(Advanced Ceramics) institute

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Version 11.04.17

➢ Grading

Lab organization and grading
For each of the 4 experiments the following 3 parts have to be passed (grade at least 4.0):

- 1/3 **Preceding test**
- 1/3 **Lab work**
- 1/3 **Report**

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➢ Grading

Lab organization and grading

For each of the 4 experiments the following 3 parts have to be passed (grade at least 4.0):

- **Preceding test:**
  - The theoretical background of the individual lab course is discussed
  - The grade is derived using a questionnaire featuring ten questions
  - If the test is not passed, the lab experiment cannot be conducted that day to ensure lab safety

Points	Grade
10	1.0
9	1.3
8	2.0
7	2.7
6	3.3
5	4.0
< 5	Not passed

➢ Grading

Lab organization and grading
For each of the 4 experiments the following 3 parts have to be passed (grade at least 4.0):

- **Lab work:** Grading according to participation and engagement
  - Dates and given times are not suggestions! Be punctual!
  - Prepare tasks at home if mentioned in the script!
  - Wear long trousers and closed shoes with a good grip! Otherwise you are not allowed to enter the lab. A lab coat and safety goggles will be provided
  - Carefully take notes so you have all the information you need for report creation

➢ Grading

Lab organization and grading

For each of the 4 experiments the following 3 parts have to be passed (grade at least 4.0):

- **Report:**
  - One report per experiment and group has to be submitted. For each report all group members will receive the same grade
  - The report has to be handed in 4 weeks after the experiment was conducted. Afterwards the supervisor has 2 weeks to revise the report and within another 2 weeks and optimized version **can be** handed in. Deadlines are not suggestions! Submit reports on time!
  - The guidelines for the creation of reports for the ceramics lab course have to be followed (script). An exemplary template for the creation of protocol is available under: http://www.ceramics.uni-bremen.de/Academic/SS/Keramiklabor/Keramiklabor.html
  - Report should be submitted as PDF or doc/docx file. Doc/docx files are preferred because they simplify the revision process

➢ Grading

Lab organization and grading
For each of the 4 experiments the following 3 parts have to be passed (grade at least 4.0):

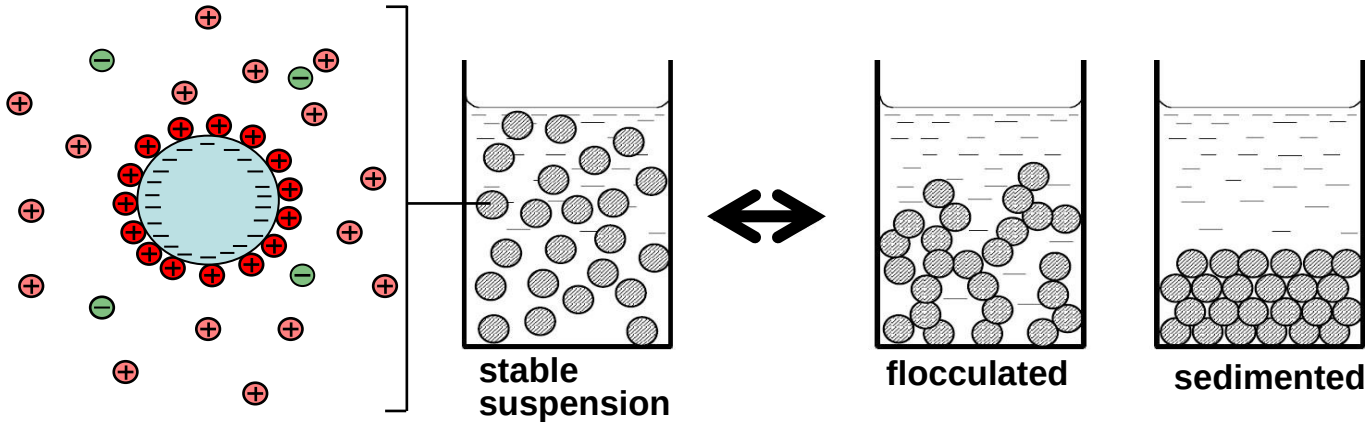
- **Report:**
  - The report will be graded based on the following scheme:

Aspect	Weighting
Structure of protocol / Abstract	5%
Theoretical background	15%
Background on measurement techniques	10%
Materials and methods	10%
Results	20%
Discussion	35%
References	5%

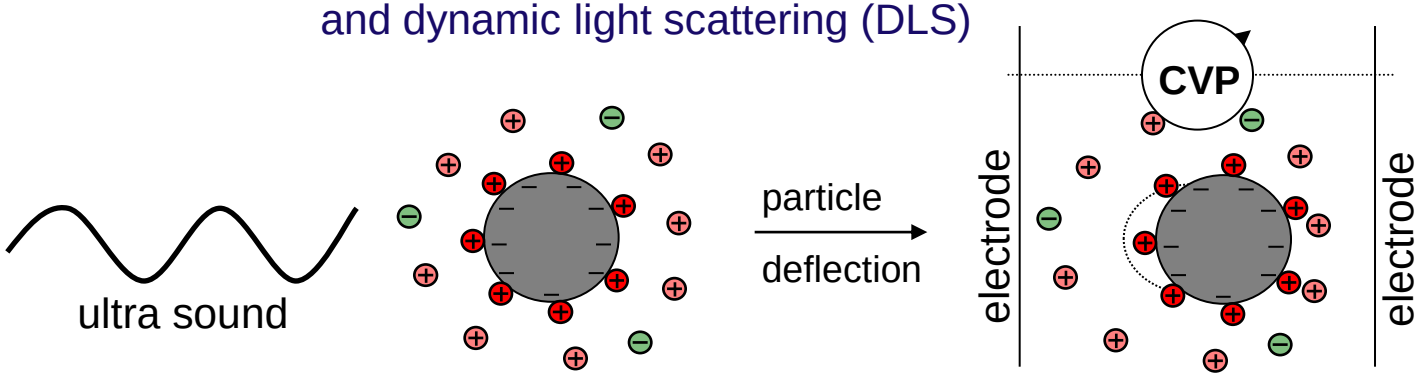
  - Based on the revisions of the supervisor the students have once the opportunity to improve their grade up to 1.3

➢ Experiment 1: Stability of ceramic suspensions and particle size determination

(T. Guo, IW3 2290, ☎ -6 4965, tguo@uni-bremen.de)



Zeta potential determination using electroacoustics and dynamic light scattering (DLS)

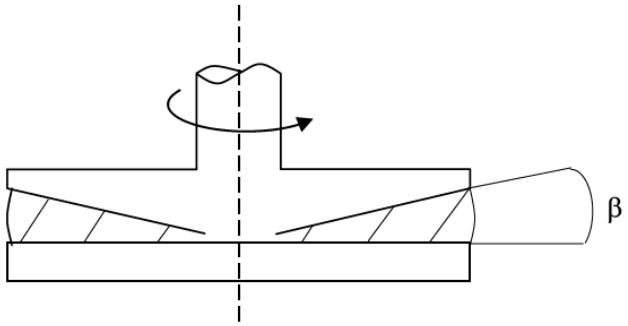


➢ Experiment 2: Flow behavior of ceramic suspensions

(M. Maas, IW3 2140, ☎ -64939, michael.maas@uni-bremen.de)

Concept of viscosity and viscoelastic fluids:

- Prepartion of ceramic suspensions (slurry)
- Execution of rheological experiments (Rheometer: Malvern Kinexus Pro)
- Viscosity: Discussion and identification of shear time-dependent and independent flow behaviour
- Viscoelasticity: Determination of storage (G‘) and loss module (G“)
- Evaluation of the effect of additives



Schematic of cone-plate arrangement used for rheological experiments

Illustration of an viscoelastic fluid as combination of spring (elastic part) and dashpot (viscous part)

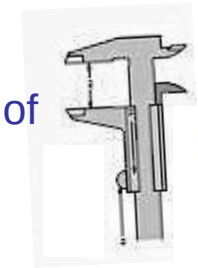
➢ Experiment 3: Determination of density in porous ceramic materials

(P. Braun & T. Kühn, IW3 2220 & 2150 ☎ -64963 & -64936, pedrohe1@uni-bremen.de & tkuehn@uni-bremen.de)

Parameters to be measured:

- Theoretical density
- Bulk density
- Apparent density
- Relative density
- Open porosity
- Closed porosity
- Total Porosity

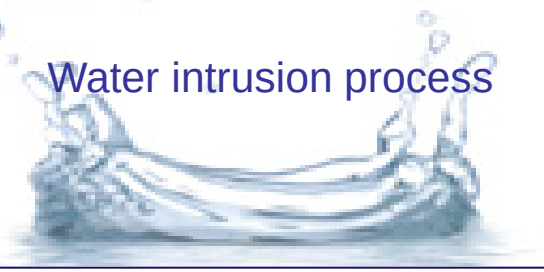
Measurement of dimensions



Helium pycnometry

Methods

Water intrusion process

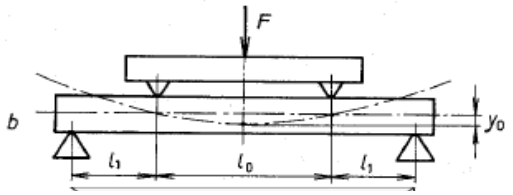


Mercury intrusion porosimetry

➢ Experiment 4: Strength and fracture toughness of ceramics

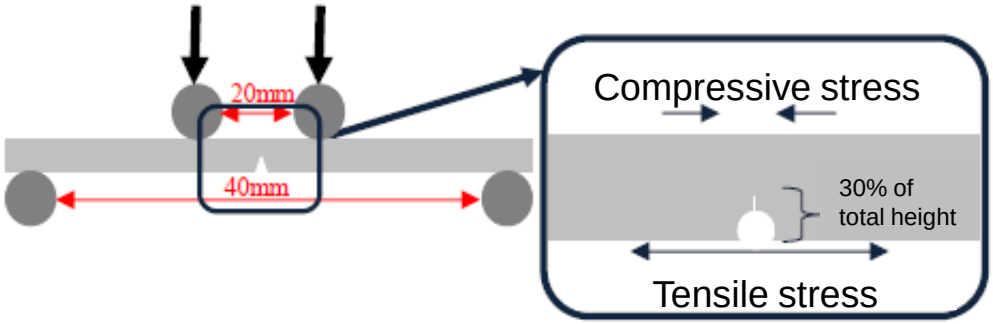
(R. Almeida, IW3 2240, ☎ -64946, renato.almeida@uni-bremen.de)

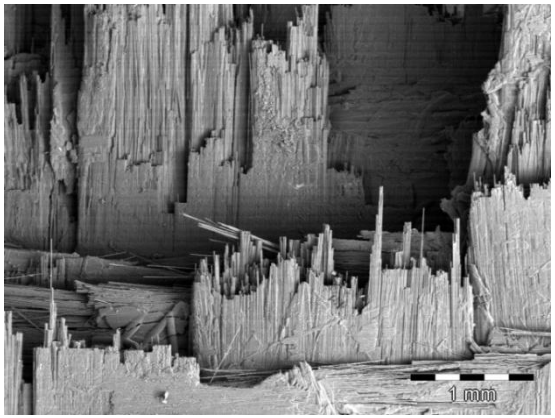
- **Strength:** Execution of bending tests, analysis using Weibull statistics, discussion of dependence of strength on microstructure



Schematic of a 4-point bending test

- **Toughness:** Different possibilities to reduce the stiffness of ceramics are discussed. Furthermore, notched samples are used to measure the materials resistance against crack propagation. Different ceramic materials and composites are tested and fracture plains are investigated.





Fracture plain of a ceramic matrix composite