



# Bachelor-, Master or Diploma Thesis

(Kann auch in Form einer Studien-, Bachelor-, Master- oder Diplomarbeit durchgeführt werden)

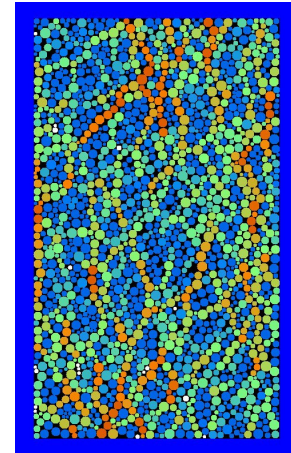
## Micro-Macro Models for Anisotropy in Granular Media and Powders

**Abstract:** The micro-mechanical behavior of granular materials and powders can be readily modeled with the discrete element method (DEM) for particle simulations. From DEM of a granular solid, one can obtain the structure (fabric), the stress- and the strain tensors in average over a sub-set of interacting particles (RVE).

On the macroscopic side, stress-strain relations are needed to model the flow behavior. The new goal of this project is to generalize classical models like elasto-plasticity by using the information from DEM particle simulations to propose new and better constitutive relations for the evolution of, e.g., deviatoric stress. Another new element will be to include a non-isotropic structure tensor into the formulation.

In particular, relations for the evolution of both deviatoric fabric and stress with deviatoric deformation involve an exponential approach to a maximum and no softening.

With the new micro-based continuum model, uni- or bi-axial shear will be studied as well as Couette ring-shear devices - in close relation to experimental and numerical data available in the literature.



**Requirements:** Background in mechanics and continuum mechanics;  
Interest in interdisciplinary work with engineers and physicists

**Duration:** according to Examination regulations  
Part of the project can be performed in Bochum, Germany / UTwente, Netherlands

### Supervisors:

Institut für Mechanik – Kontinuumsmechanik  
Prof. Dr.-Ing. Holger Steeb  
Ruhr-Universität Bochum, IA 03/26  
Phone.: +49-(0)234-32-23080  
E-Mail: [holger.steeb@rub.de](mailto:holger.steeb@rub.de)

Multi Scale Mechanics  
Prof. Dr. rer-nat. Stefan Luding  
University of Twente, The Netherlands  
Phone: +31-(0)53 489-4212  
E-Mail: [s.luding@utwente.nl](mailto:s.luding@utwente.nl)