RUHR-UNIVERSITÄT BOCHUM

RUB

Research Internship offers from Ruhr-Universität Bochum 2011

1. ICAMS

The Interdisciplinary Centre for Advanced Materials Simulation (ICAMS) is a newly founded research centre at the Ruhr-Universität Bochum, Germany. ICAMS focuses on the development and application of a new generation of simulation tools for multi-scale materials modelling with the aim of reducing development cost and time for new materials. Within the approach taken by ICAMS, the different length scales that are relevant for materials - from the atomic structure to macroscopic properties of materials - are bridged by an interdisciplinary team of scientists from engineering, materials science, chemistry, physics and mathematics.

In the department “Micromechanical and Macroscopic Modeling” our research work is focused on analyzing and understanding the micromechanisms of the deformation and failure of engineering materials. The understanding of these mechanisms allows us to predict mechanical properties of materials and thus to support design of novel materials.
We offer undergraduate research projects in the following areas:

- Large-scale atomistic simulations of nanoindentation
- Modelling fracture of ceramics (atomistic and/or cohesive zone models)
- Finite element models of deformation of heterogeneous materials (continuum models at the level of individual grains and phases)

Students should know and be able to apply the basic principles of mechanical metallurgy to materials related problems. An interest to work with numerical methods is of course necessary, but programming skills are not required.

Contact:
Prof. Dr. Alexander Hartmaier
Chair of Micromechanical and Macroscopic Modelling
Interdisciplinary Centre for Advanced Materials Simulation (ICAMS)
Ruhr University Bochum
Homepage: www.icams.rub.de
Email: Alexander.Hartmaier@rub.de

2. Institute of Mechanics

The Institute of Mechanics is working on various problems of modern solid mechanics. This concerns fundamental research as well numerical simulations and experiments. A strong focus is put on the development of continuum mechanical and micro-mechanical models for different materials and their implementation into effective numerical environments.

Specific applications of these models come, among others, from mechanical engineering and material science, geosciences and biomechanics.

The institute offers a lively, international research environment. There are constantly several Ph.D. students and Postdocs from around the world working here. Students are integrated within the running research projects. Many courses are taught in English, which is also the language of the institute's seminars.

We are specifically interested in students with a background in mechanical engineering, civil engineering, material science, physics or mathematics. Some experience in numerical algorithms, e.g. the finite element method is of advantage, but can also be acquired while staying at the institute.

Contact:
Prof. Dr. Klaus Hackl
Email: Klaus.Hackl@rub.de
Homepage: www.rub.de/lam

3. Institute of Communication Acoustics

Digital Speech and Audio Processing for Hearing Aids and Mobile Communications

The Institute of Communication Acoustics at the Department of Electrical Engineering and Information Technology performs research in speech and audio processing with emphasis on statistical signal processing for single and multi-channel speech and audio enhancement, sound reproduction, and virtual acoustics. Typical applications we work on are hearing aids, voice front-ends for mobile communications, and man-machine interfaces. In the summer of 2010 we offer undergraduate internships in the areas listed below. We are especially interested in students with a background in EE/ECE and signal processing.

Topics for undergraduate internships:

- Single channel noise reduction
- Source localization with microphone arrays
- (Blind) Source separation
- Hands-free voice communication in adverse conditions
- Audio signal analysis and classification
- Models of hearing and (computational) auditory scene analysis
- Real-time interactive virtual acoustics

Contact:
Prof. Dr.-Ing. Rainer Martin
Chair of Information Technology and Communication Acoustics
Dept. Electrical Engineering and Information Technology, Ruhr-Universität Bochum
Homepage: www.rub.de/ika
Email: rainer.martin@rub.de

4. Institute of Mechanics – Continuum Mechanics

The research activities at the institute of Mechanics – Continuum Mechanics cover a broad range of interesting engineering problems, such as the theoretical and numerical investigations of multi-scale and multi-phase aspects of heterogeneous and porous materials like natural rocks and soils, artificial foams, smart materials or soft and hard biological tissues. Research studies are performed experimentally in the institute's laboratory as well as numerically using standard and research finite element codes or other numerical software, respectively. Regarding these research topics, we offer an undergraduate internship in 4 different fields:

Project (I): Experimental investigations of dispersion effects in smart/cellular materials

In quasi-static experiments, materials with lattice-type microstructure like foams show a size effect which is pronounced if the inherent length scale of the microstructure is in the same order of magnitude as the size of the specimen.Taking into account higher order continua with intrinsic length scales, it is well-known that this size-dependency can be captured on the macro-scale by various mean-field approaches (micropolar/microstretch/micromorphic/strain gradient/nonlocal continua). Besides size effects observed in quasi-static experiments, phononic band-gaps, i.e., frequency bands with no propagating waves, are a characteristic property of materials with lattice-type microstructure in dynamical or acoustical investigations. As the band-gaps strongly depend both on the mass and stiffness distribution and on the geometrical configuration of the discrete microstructure, the band gaps could evolve during large deformations. This specific material behaviour is of interest to design novel phononic devices, e.g., sound filters and acoustic mirrors

Many of these effects are still not understood as the signal-to-noise ratio of the experimentally obtained data is often too bad and standard data analysing techniques (e.g. FFT-Fast Fourier Transform) are questionable for experiments with small ratios of wavelength/internal length of the material. Therefore, transmission experiments have to be performed in an acoustic cell (hydrostatic conditions) with broadband ultrasound transducers in order to use the wavelet transform to analyze the waveforms in the time/frequency range.

Recommendation: Background in continuum mechanics; Matlab experiences; interest in interdisciplinary work.

Project (II): Numerical homogenization of waves in bubbly fluids Modeling

The propagation of acoustic or fully elastic waves is an important tool for interpreting, understanding and predicting real-world measurements in various industrial disciplines. In this context, modeling can be anything from three-dimensional full waveform modeling using numerical techniques to analytical treatment of wave phenomena in the time as well as the frequency domain. In its most simple form, the propagation of waves through a heterogeneous medium is described with a linear elastic material behaviour. Within a medium containing any kind of heterogeneity, like bubbly fluids, oscillations with a characteristic resonance frequency, depending on the mass and internal length of the bubbles, are detected. In numerical models the complexity and the computational cost increases with an increasing number of bubbles. Therefore, macro-scale models take these effects into account in a homogenized way. To this end, numerical investigations of propagating waves have to be performed on the heterogeneous micro-scale using a three-dimensional commercial finite element solver (COMSOL Multiphysics) and effective quantities (e.g. phase velocity, reflection coefficients, attenuation) have to be derived and compared to recently developed macro-scale models.

Recommendation: Background in continuum mechanics and finite element methods; interest in interdisciplinary work

Project (III): Physical modeling of bentonite suspensions

In industrial tunneling bentonite suspensions are of vital importance. Hence, theoretical and numerical modelling of the behaviour of this complex non-Newtonian fluid is an important research topic. The project is about material and rheological modelling as well as simple numerical studies of the infiltration process of a bentonite suspension into the surrounding porous soil. Of particular interest is the question how the fines, i.e. the small-scale particles of the suspension move relative to the (mean) velocity of the suspension, and, if and how they are clogged in the soil. Of special interest is e.g. the evolution of localized filter cakes and the the evolution of effective hydraulic parameters of the porous medium and the bentonite suspension. The numerical treatment is accomplished by the Galerkin finite element method.

Recommendation: Background in continuum mechanics and finite element methods; Matlab experience

Project (IV): Investigations of interfacial areas in multiphase materials

Physical processes of multi-phase systems can be modelled on the macro-scale by the so-called continuum-mixture theory (MT) enhanced by the concept of volume fraction. Although this phenomenological approach has led to many powerful thermodynamically consistent models for a wide range of applications there are still effects on a smaller, i.e. micro scale which are not considered by these models. E.g. in many applications the amount of interfacial area plays a vital role. Though volume fractions are of the same magnitude, the interfacial area may differ leading to different material responses (e.g. melting of ice in water, dissolving sugar in hot coffee). In this project simple numerical investigations will be performed with the aim of incorporating interfacial-area-related terms into the thermo-dynamically consistent macroscopic approach. The numerical studies are performed by the commercial finite element tool COMSOL Multiphysics.

Recommendation: Background in continuum mechanics and finite element methods; Matlab experience

Contact:
Prof. Dr.-Ing. Holger Steeb
Mechanics – Continuum Mechanics
Faculty of Civil and Environmental Engineering,
Ruhr University Bochum
Homepage: www.lkm.rub.de
Email: holger.steeb@.rub.de