Peter the Great St. Petersburg Polytechnic University	**Leibniz University Hannover**
Institute of Applied Mathematics and Mechanics	Institute of Mechanics and Computational Mechanics
Prof. Dr.-Sci. Anton Krivtsov Head of Department of Theoretical Mechanics	**Prof. Dr.-Ing. Udo Nackenhorst** Professor for Computational Mechanics of Solids
	
Department of Theoretical Mechanics Institute of Applied Mathematics and Mechanics St. Petersburg State Polytechnical University Polytechnicheskaya, 29 Russia, 195251, St.Petersburg Phone: +7 812.290-9872 E-Mail: akrivtsov@bk.ru	Institut für Baumechanik und Numerische Mechanik Leibniz Universität Hannover Appelstraße 9a 30167 Hannover, Germany Phone: +49 511 762-3560 E-Mail: nackenhorst@ibnm.uni-hannover.de

BRIEF DESCRIPTION OF THE UNIT / RESEARCH GROUP

A joint German-Russian research group headed by two principal investigators (Prof. Nackenhorst and Prof. Krivtsov) develops novel and innovative methods for the prediction of the behavior of engineering materials and structures. Challenges of this research collaboration are on scale bridging techniques in space and time, e.g. concurrent coupling of molecular dynamics (MD), discrete element methods (DEM) and sophisticated finite element methods, e.g. (X-FEM). Innovative mathematical and computational methods with emphasis on the treatment of wear and fatigue of materials and the treatment of uncertainties are under investigation. The cooperation was finished in 2018.

WHAT WE OFFER / PROJECT DESCRIPTION

We offer applied research in co-operation with technology companies and research institutions within the frames of two projects:

Project 1 Mechanics of Solid Materials – Damage, Fracture, Fatigue and Tailored Design

Members:

SPbSPU: Prof. A. M. Krivtsov, Prof. V. A. Polyanskiy, Prof. B. E. Melnikov, Dr. M. E. Frolov, Dr. S. V. Lupulyak

LUH: Prof. U. Nackenhorst, Prof. P. Wriggers, Dr. S. Löhnert, Dr. A. Fau

The project is devoted to experimental investigations and mathematical modeling on mechanics of solid materials, especially on inelastic and multiphysics phenomena at Saint Petersburg, whereas related competences in sophisticated computational techniques in this field are in Hannover. Merging these specific expertises would give a further impact to this important field of scientific work.

One special subject for application of common interest has been identified so far, which is on hydrogen embrittlement of semiconductor materials and metals with applications to electronic devices and e.g. hydrogen storage devices or highly stressed bolt within a huge operational temperature regime. Cyclic fatigue modeling, crack prediction and stochastic uncertainty modeling strategies are in the scope of these scientific developments.

Applied mathematics (Dr. Frolov, Dr. Lupuleac) will contribute with numerical algorithms, modern finite element methods, and sophisticated error estimates for partial differential equations, which describe the relevant advection-diffusion-reaction problems.

Experimental investigations are needed for quantified hydrogen atmosphere exposure of specimen, systematic tests on the change of mechanical properties of specimen and quantified micro-structural analysis. Professor Polyanskiy has rich research experience on these phenomena, Professor Melnikov can provide related experiments and Professor Nackenhorst is working on sophisticated computational techniques for the solution of non-linearly coupled equations with uncertain parameters.

Project 2 Multi-Scale Methods

Members:
SPbSPU: Prof. A. M. Krivtsov, Prof. B. E. Melnikov, Prof. V. A. Polyanskiy, Dr. I. E. Berinskii
LUH: Prof. U. Nackenhorst, Prof. P. Wriggers, Dr. A. Fau

Some innovative ideas like introduction of advanced analytical solutions into numerical approaches e.g. the use of micro-polar continuums methods for scale-bridging within the overlapping domain and sophisticated upscaling techniques to end up in a thermodynamic consistent internal variable continuums approach are investigated.

As fields of applications within the group of participants topics such as single crystal mechanics, solid-liquid phase change, phenomena of super-plasticity, nano-electro-mechanical systems, bone-fracture mechanics, reinforced concrete and geo-mechanical applications and related analogies between fluid flux in fractured media and subsoil have been sampled. From that these methodical driven research approach provide a broad area of applications. Thus it provides an overall framework for engineering applications.

KEYWORDS

- **Mechanics of Solid Materials**
  - Fatigue and Fracture of solid materials
  - Chemical Attack to Solids, e.g. Hydrogen embrittlement
- **Multi-Scale Methods**
  - Concurrent Coupling of Molecular Dynamics, Discrete Element Method and Finite Element Method
  - Scale Bridging Techniques in Space and Time, e.g. High Cycle Fatigue
  - Uncertainty Modeling Techniques and Model Reduction

COLLABORATION SOUGHT
Research & Development, Technical Co-operation, etc.