1
2

1   *Metal tibial tray*

2   *Positioning of the pros-*
*thesis within the simulation*
tool KneeMech for

Products

KnowCube: Multicriterial Decision Support

Usage of visual multicriterial navigation in precomputed data base to choose yarn and structure of textile, such that an optimal combination of

- stretching
- stiffness
- strength
- costs

is guaranteed.

MODELING AND SIMULATION OF COMPOSITES, TEXTILES, POROUS MATERIALS AND ROUGH SURFACES
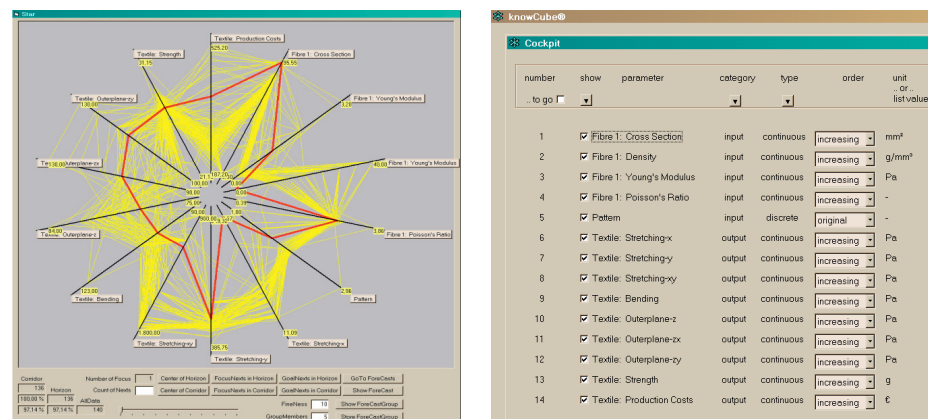
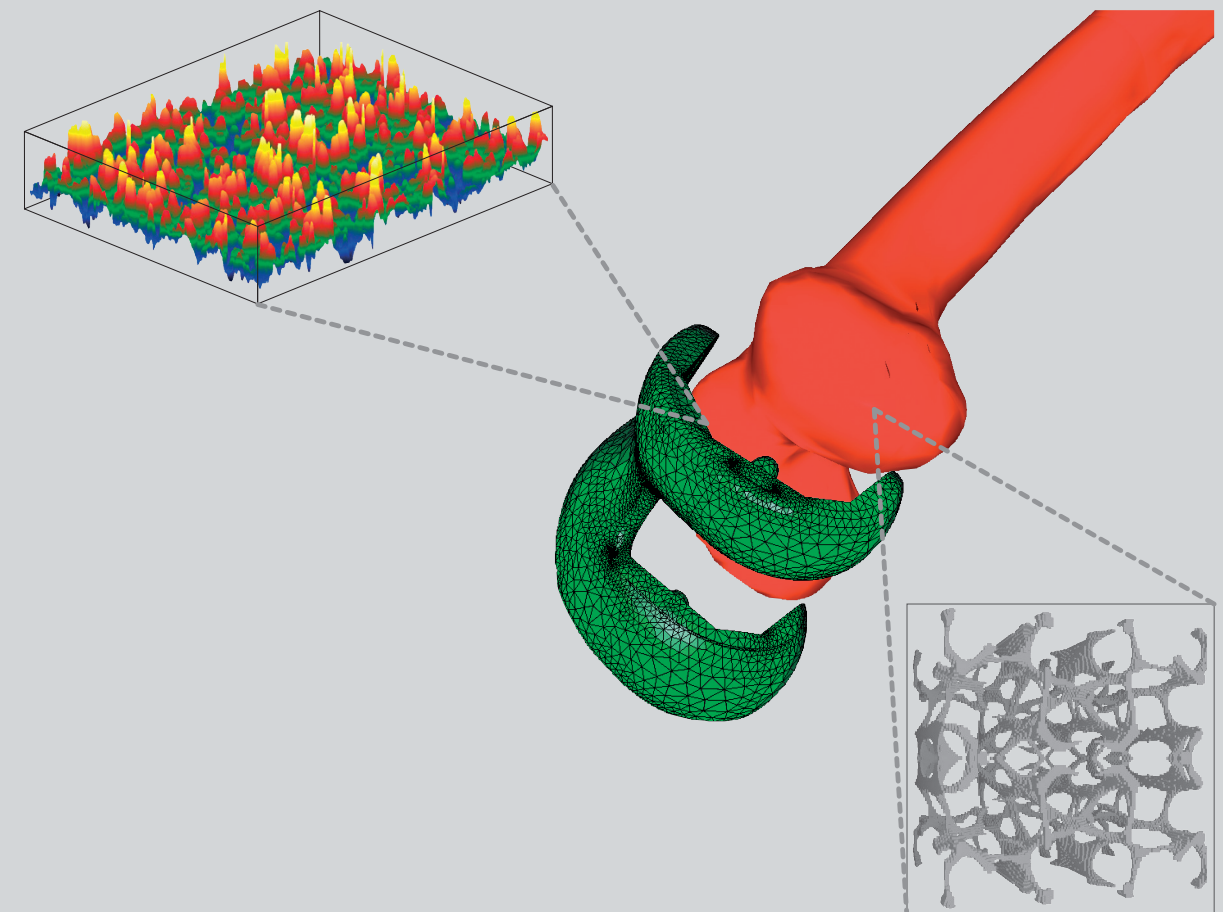### KneeMech: Preoperative surgical planning

Helps surgeons on basis of

- patient CT data
- effective time and space dependent loading conditions

to make

- a correct virtual bone cut and positioning of the prosthesis in the bone
- a preoperative choice of appropriate shape, size, material and coating for the knee prosthesis for each patient

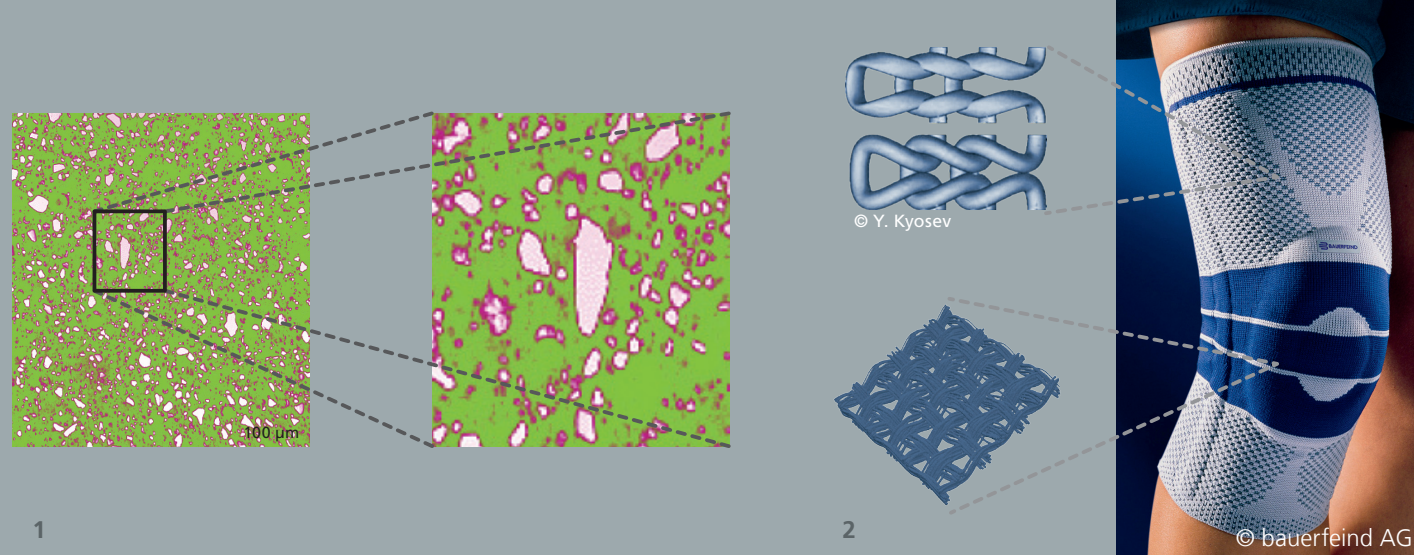**Fraunhofer-Institut für Techno- und Wirtschaftsmathematik ITWM**

Fraunhofer-Platz 1
67663 Kaiserslautern
Germany

Contact
Dr. Julia Orlik
Phone +49 (0) 6 31/3 16 00-43 30
julia.orlik@itwm.fraunhofer.de

Dr. Konrad Steiner
Head of department "Flow and material simulation"
Phone +49 (0) 6 31/3 16 00-43 32
konrad.steiner@itwm.fraunhofer.de

www.itwm.fraunhofer.de

sms_flyer_Modeling and Simulation of Composites_EN

1 *Composite filling for teeth*

2 *Knitted materials*

© Y. Kyosev

© bauerfeind AG

Image and mechanical properties of components or fibers

Image analysis

Homogenization algorithms

Microstructure simulation

Macroscopic material parameters

Experimental verification

Problem

We are mainly working on three subjects here. The first one refers to the numerical computation of the microscopic stress-strain behavior and effective material properties of composite or porous materials. We apply homogenization methods which allow for the computation of average (effective) elastic, viscoelastic, plastic, heat conduction, permeability material properties, accounting for the microstructure and the different constitutive laws. The computation of effective free temperature deformation, swelling, and shrinkage is also possible. The second subject deals with contact problems with micro-rough surfaces, which also can be solved by homogenization methods. Finally, within the third problem complex we consider time-dependent processes for composites, whose macro strength and durability are examined with respect to fatigue, creep strain, impact load, and wear.

Homogenization methods are applied if the composite material shows strongly differing size scales. In this case, a direct computation of properties and effects on the macro scale is mostly impossible due to the enormous efforts, for accounting the exact microstructure. The homogenization method, which is applied here, works with an asymptotic expansion of the entire problem with respect to the length ratio of the micro and macro scales. Compared to other, simpler averaging methods, such as self-consistent methods, which can only be applied to special types of geometry, asymptotic homogenization methods have the essential advantage that they lead to reliable results for arbitrary microstructures and many different material laws.

We are developing and applying methods and tools, which are necessary for the analysis, modeling, simulation, optimization and verification of effective mechanical properties of composites, porous and textile materials. Typical applications are coming from the fields of composites, medical implants and technical textiles.
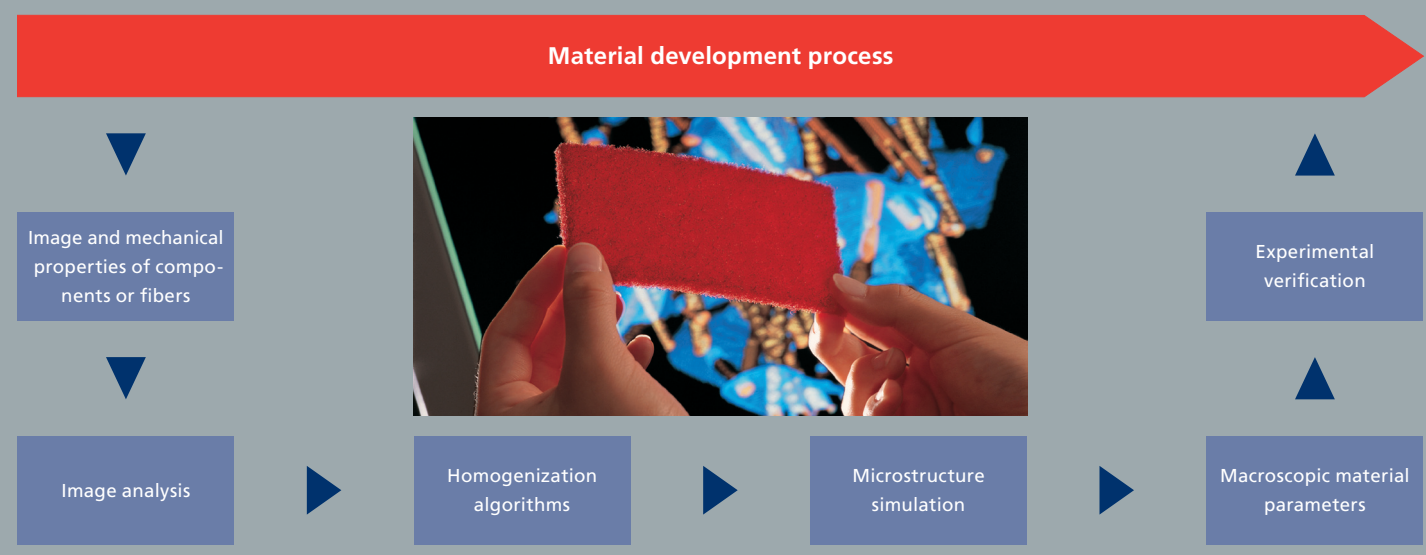
We offer

Consulting, simulation and software tools for efficient computation of effective

- elastic, visco-elastic, plastic properties
- strength, durability and yield surface
- contact stiffness, frictional traction
- heat conduction
- permeability

for composites, technical textiles, porous materials, rough surfaces and contact layers based on the material structure and the corresponding fiber or component properties

Our Competences

- Upscaling techniques
- Modelling of constitutive laws for visco-elastic and elastoplastic materials
- Mechanical contact problems
- Durability analysis
- FE based algorithms and simulation tools
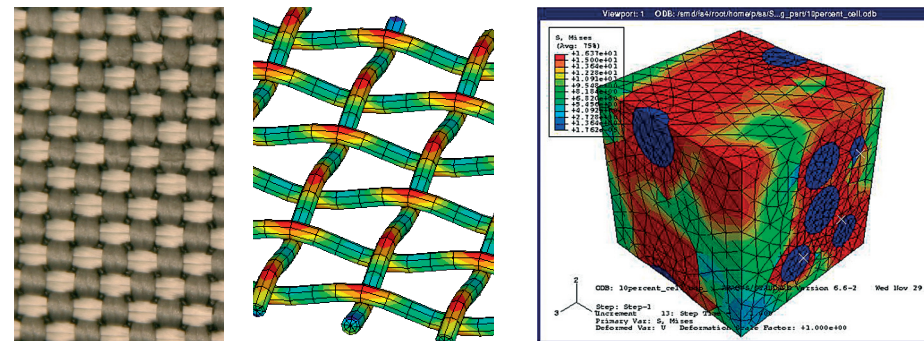
3 *Woven textile*

4 *Simulation*

5 *Simulation of volume element of a metal-matrix composite*