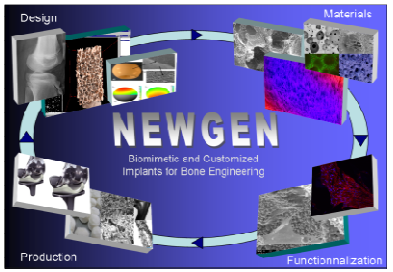
TU Wien (Vienna University of Technology)

GENERAL PRESENTATION

- **Complete denomination**: Institute for Mechanics of Materials and Structures, Vienna University of Technology
- **Location (city, country)**: Vienna, Austria
- **Director**: Prof. Christian Hellmich
- **Contact person in NEWGEN**: Dr. Stefan Scheiner (stefan.scheiner@tuwien.ac.at)
- **Working Group involvement**: WG2
- **Staff**: 3 professors, 11 postdoctoral researchers and lecturers, 16 PhD students, 4 technicians/engineers
- **Research topics**: Characterization of biological and engineering materials, mathematical systems biology
- **Researchers expertises**: Multiscale modeling of material properties, mechanical testing, CT image-to-mechanical properties conversion, corrosion modeling, mathematical modeling of biological systems

TUW (IMWS)
Vienna University of Technology
Karlsplatz 13/202
A-1040 Vienna, Austria



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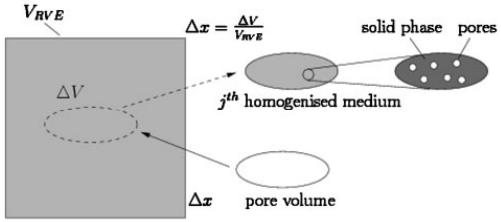
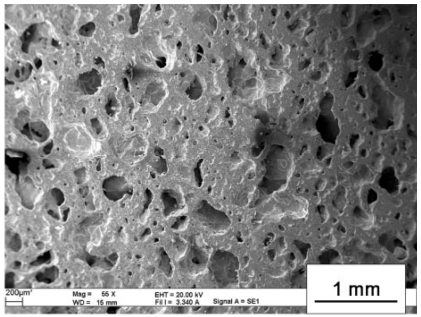
CERAMICS

STIFFNESS AND STRENGTH DETERMINATION of glass-ceramic scaffolds:

- Prediction via micromechanics-based **homogenization models**
- Sample **characterization** (for experimental validation) through **ultrasonics and uniaxial compression tests**

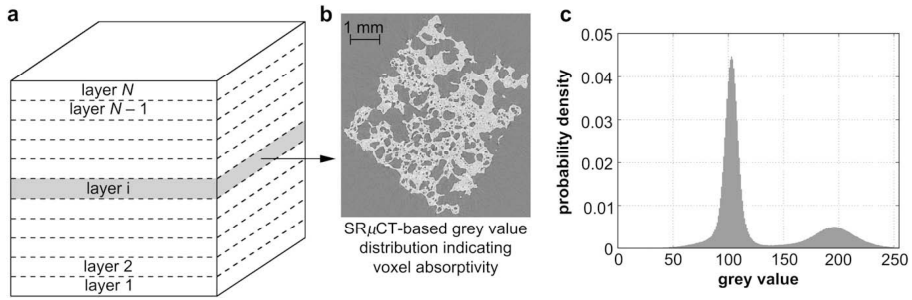


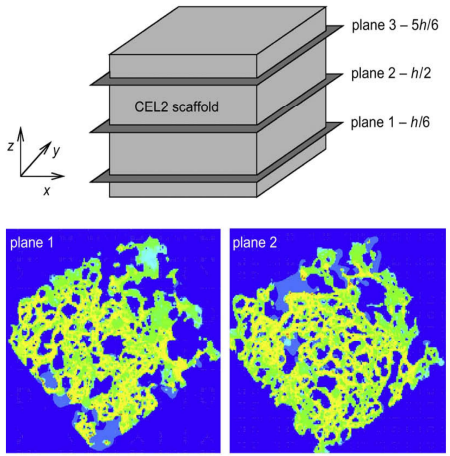


Malasoma et al. (2008), *Adv Appl Ceram* 107: 277-286; Kariem et al. (2015) *Mat Sci Eng C-Mater* 46: 553-564

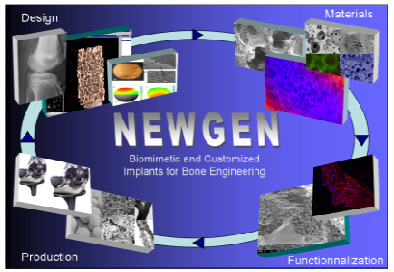
CT IMAGE-TO-PROPERTIES CONVERSION, applied to glass-ceramic scaffolds:

Interpretation of CT image as nanoporosity distribution – Micromechanical conversion into 3D stiffness field – FE simulation of compression test – **Computation of macroscopic sample stiffness**





Scheiner et al. (2009), *Biomaterials 30*: 2411-2419; Czenek et al. (2014) *J Mater Res* 29: 2757-2772



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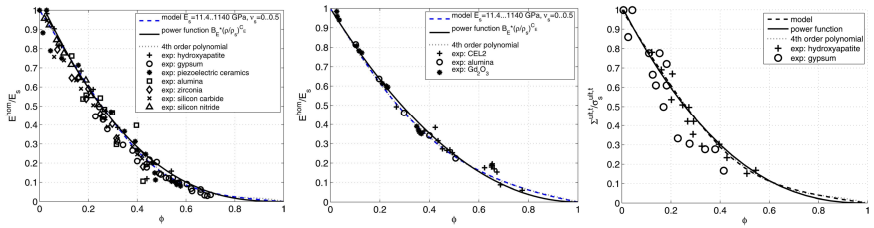
CERAMICS – cont'd

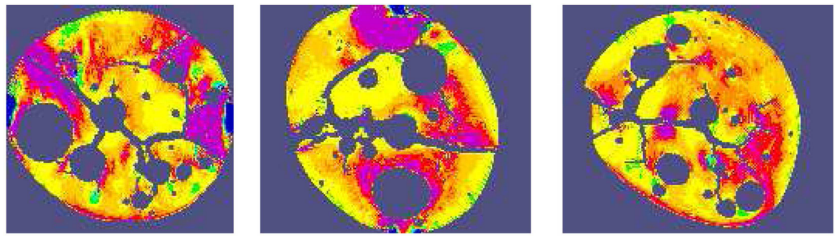
ANALYTICAL/NUMERICAL MODELS FOR HYDROXYAPATITE BIOMATERIALS:

- Micromechanical homogenization schemes for **(poro-) elasticity and strength**

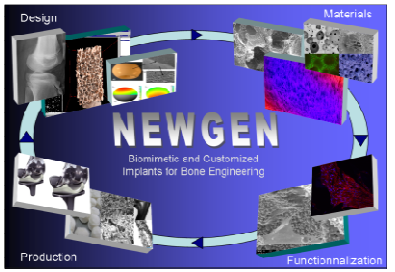


Fritsch et al. (2006), *CR Mech* 334: 151-157; Fritsch et al. (2007), *J Mater* Sci 42: 8824-8837; Fritsch et al. (2009), *J Biomed Mater Res A* 88: 149-161; Fritsch et al. (2010), *Philos Trans A Math Phys Eng* Sci 368: 1913-1935; Fritsch et al. (2013), *J Appl Mech* 80: 020905

- CT-based, **micromechanical/numerical elasticity analysis** of HAP granules



Dejaco et al. (2012), *J Biomech* 45: 1068-1075



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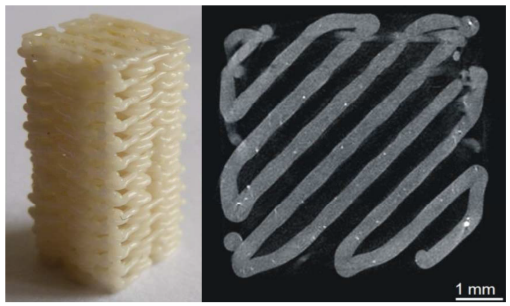
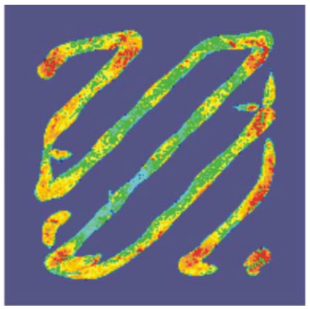
COMPOSITES

COMPREHENSIVE INVESTIGATION OF POLYMER-BASED COMPOSITE MATERIALS:

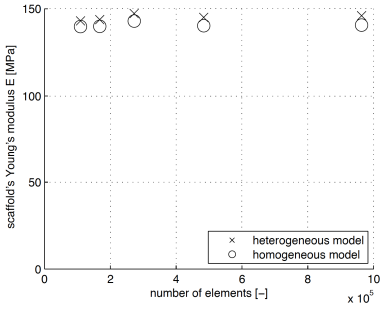
MicroCT imaging



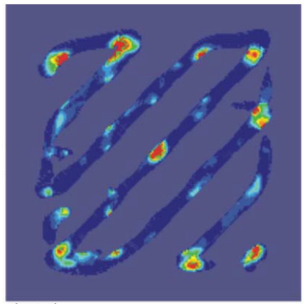
CT-to-elasticity conversion



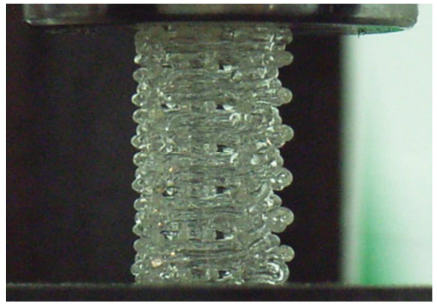
Computation of macroscopic stiffness



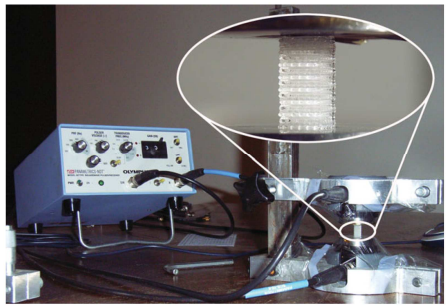
FE-based utilization assessment



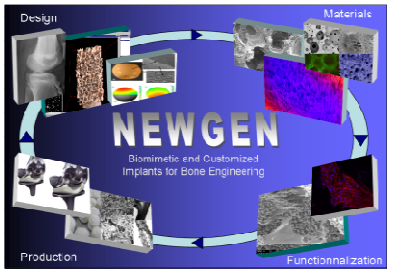
Uniaxial loading-unloading tests



Ultrasonics tests for stiffness determination



Further accompanied by **nanoindentation tests** for material characterization on the millimeter scale



Luczynski et al. (2012), *CMES-Comp Model Eng* 87: 505-528; Luczynski et al. (2013), *J Biomed Mat Res A* 101A: 138-144; Hum et al. (2013), *Strain* 49: 431-439; Li et al. (2014), *J Mech Behav Biomed* 40: 85-94

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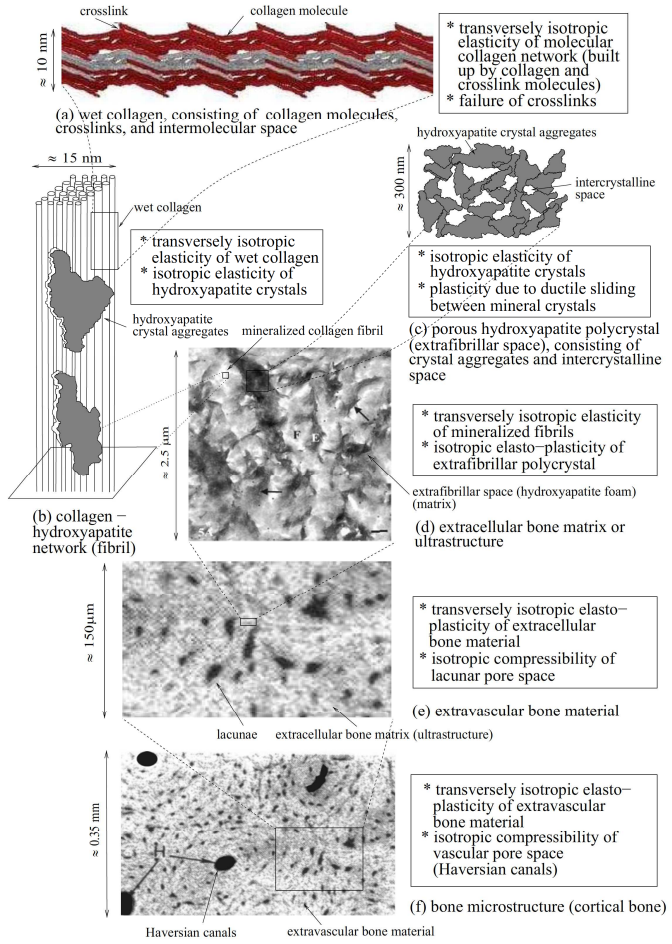
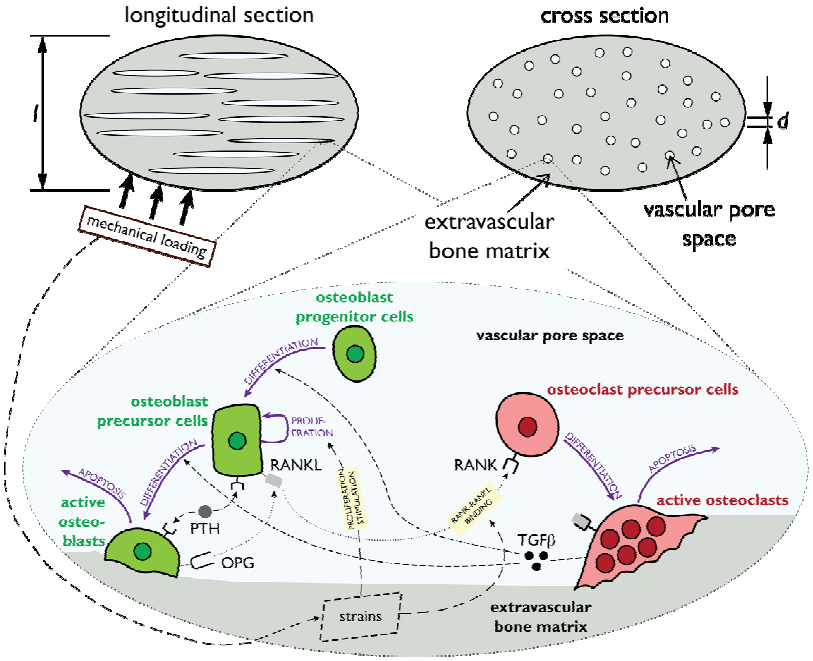
COMPOSITES – cont'd

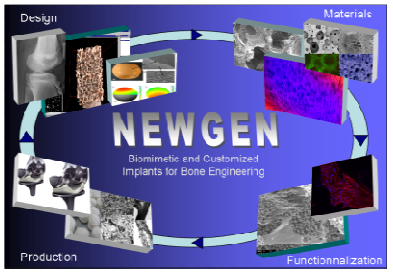
MICROMECHANICAL BONE PORO-ELASTICITY AND STRENGTH MODELS:



New route: Coupling with systems biology approaches, for computational monitoring of bone composition changes



Fritsch et al. (2009), *J Theor Biol* 260: 230-252; Hellmich et al. (2009), *J Eng Mech* 135: 382-394; Scheiner et al. (2013), *Comput Meth Appl M* 254: 181-196; Scheiner et al. (2014), *Int J Numer Method Biomed Eng* 30: 1-27



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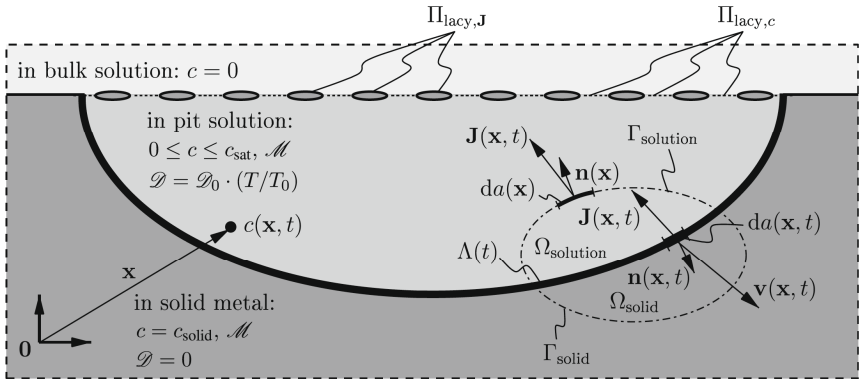
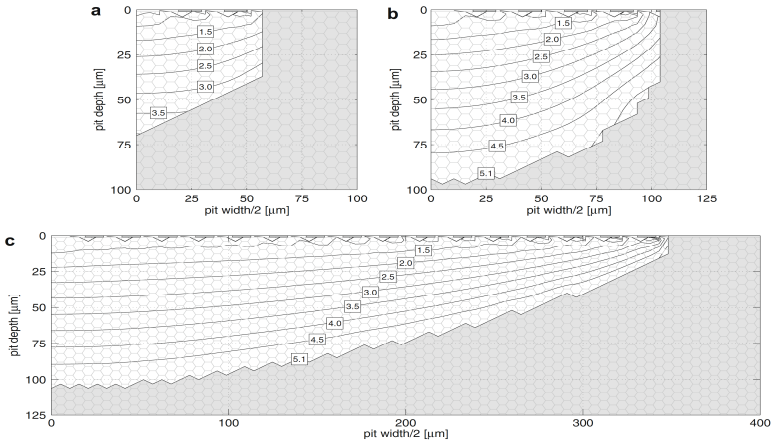
METALS

ANALYTICAL AND NUMERICAL MODELING OF PITTING CORROSION:

Through combination of:

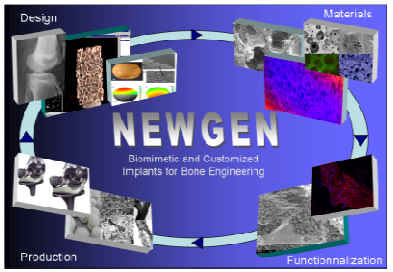
- **Mass balance** for continua with progressing fronts;
- Classical **electrochemical** (Butler-Volmer-type) **kinetics** law;
- **Fick's law of diffusion**
- Numerical solution by means of the **FVM**





Computation of corrosion pit profiles, following from specific electrochemical boundary conditions

Scheiner and Hellmich (2007), *Corr Sci* 37:1947-1967; Scheiner and Hellmich (2009), *Comp Meth Appl M* 198: 2898-2910



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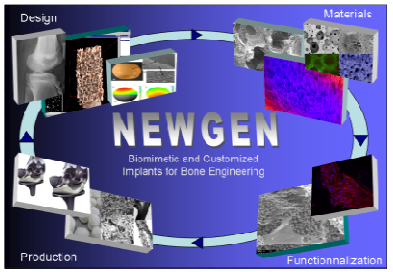
FACILITIES

- State-of-the-art computational facilities, including access to the TUW Supercomputing Cluster
- Macroscopic material testing laboratory, including uniaxial and triaxial testing devices, a permeability testing chamber, a 3D electronic speckle pattern interferometry system, a linear friction tester, a biaxial membrane test rig, differential calorimetry, ultrasonic testing facilities
- Micro- and nanomechanical laboratory for biological and biomimetic materials, including microCT, lightmicroscopy, a high-speed camera, nanoindentation, scanning probe microscopy, mechanical testing, and sample preparation



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