BuildMoNa

UNIVERSITÄT LEIPZIG

SCIENTIFIC AND METHOD MODULES

Module name	**Multifunctional scaffolds**
Number	2012-T2
Aims	The module aims at providing the scientific background required to study and manipulate biopolymers, biopolymer networks, proteins and protein networks, including the highly dynamic polymer scaffolds in living tissues as an organizing matrix for smart nanoelements, molecular motors, mechano-sensing, in natural and artificial nanoscopic devices for force-generation, motile polymeric machines, biomimetic devices etc.
Basics	The topics covered in soft matter and biophysics lectures from the existing master program; basic knowledge about biopolymers and proteins (protein structure, DNA, actin, microtubules), viscoelasticity, statistical physics
Contents	Physical, biochemical & biological perspective on various multifunctional scaffolds and modern experimental techniques. Topics comprise general soft matter properties, statistical physics and simulation approaches, protein aggregates, complex interactions in aqueous media, biopolymers, biopolymer networks, composite biopolymer networks, including molecular motors, cytoskeleton & extra-cellular matrix, living cells.
Methods	Single molecule imaging/tracking, advanced microscopy, rheology, micro-rheology, in-vitro 3-dim scaffolds, biochemistry, statistical mechanics, theoretical modeling, computer simulations
Type	Two-day block course/ yearly recurrence with modification
Date (month/year)	27.9.-28.9. 2012
Time	9h – 18:30h, 9h – 16:00h , ITP (Brüderstraße) Room 113
Work load	15 hours presence/ 45 hours self-study
Examination	written exam 8.10.2012
Credit points	2
Responsible scientists	K. Kroy, T. Pompe, F. Kremer, W. Janke
International guest lecturers	John Dunlop (MPI Golm) Claus Heussinger (Univ. Göttingen) Anders Irbäck (Univ. Lund) Martin Steinhauser (FRIAS Freiburg) Norman Wagner (Univ. Delaware)

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Recommendations for literature, e-learning	**Introductory**: M.E. Tuckerman, "Statistical Mechanics: Theory and Molecular Simulation" (Oxford, 2010), chapter 7; J. Mewis, N. Wagner: Colloidal Suspension Rheology (Cambridge, 2011) M. O. Steinhauser: Computational Multiscale Modeling of Fluids and Solids (Springer 2008) chapter 1,2, 6; Chapter 1 in: "Molecular Dynamics - Studies of Synthetic and Biological Macromolecules" http://www.intechopen.com/books/molecular-dynamics-studies-of-synthetic-and-biological-macromolecules **Further Reading:** T.P.J. Knowles, M.J. Buehler, Nanomechanics of functional and pathological amyloid materials, Nature Nanotechnology 6, 469-479 (2011); S. Mitternacht et al., Monte Carlo study of the formation and conformational properties of Aβ42 variants, Journal of Molecular Biology 410, 357-367 (2011); Bidan, C.M. et al., PLoS ONE, 7(5), e36336 (2012) How Linear Tension Converts to Curvature: Geometric Control of Bone Tissue Growth; P. Kollmannsberger, et al., Soft Matter, 7, 9549–9560 (2011): The physics of tissue patterning and extracellular matrix organisation: how cells join forces; P. Fratzl, F. G. Barth, Nature, 462, 442–448 (2009): Biomaterial systems for mechanosensing and actuation; I. Burgert, P. Fratzl, Phil. Trans. R. Soc. A 367 1541–1557 (2009): Actuation systems in plants as prototypes for bioinspired devices. C. Heussinger, et al.: Nonaffine rubber elasticity for stiff polymer networks, Phys. Rev. E76 031906 (2007); C. Heussinger: Cooperative crosslink (un)binding in slowly driven bundles of semiflexible filaments, Phys. Rev. E83 050902(R) (2011); M. Steinhauser: Shock-wave induced damage in lipid bilayers: a dissipative particle dynamics simulation study, Soft Matter, 7, 4307 (2011), A Review of Computational Methods in Materials Science: Examples from Shock-Wave and Polymer Physics, Int. J. Mol. Sci., 5135-5216 (2009), Energy-based coupling of smooth particle hydrodynamics and molecular dynamics with thermal fluctuations, Eur. Phys. J. Special Topics, 206, 51-60 (2012)

SCHEDULE 2012

Time	Lecturer	Title
27.9.2011		
9:00-9:30	Klaus Kroy	Introduction
9:30-11:00	Martin Steinhauser	Computational Modeling of Shock Waves in Biological Cells
11:00-12:30	John Dunlop	The role of substrate geometry on tissue growth
LUNCH	(served on site)	Informal discussions
13:30-15:00	Martin Steinhauser	Computational Modeling of Shock Waves in Biological Cells
15:00-16:30	Anders Irbäck	All-atom Monte Carlo approach to protein folding and misfolding
16:30-18:00	Claus Heussinger	Mechanics of biopolymeric assemblies: filaments, bundles, networks (I)
18:00-18:30	All participants	Plenary Discussion
28.9.2011		
09:00-10:30	John Dunlop	The role of tissue architecture on hygroscopic actuation of plant organs
10:30-12:00	Anders Irbäck	Coarse-grained approach to amyloid fibril nucleation and growth
12:00-13:30	Claus Heussinger	Mechanics of biopolymeric assemblies: filaments, bundles, networks (II)
LUNCH	(served on site)	Informal discussions
14:30-16:00	Norman Wagner	New methods to understand steady and transient flow in complex fluids

Didactic elements:
Lectures, plenary discussions and exercises, etc.

Expected performance:
Active participation in discussions, exercises, and written examination