SYDI 1: SKM Dissertation Prize 2010

Time: Tuesday 13:30–15:30 Location: H10

Invited Talk SYDI 1.1 Tue 13:30 H10

Modeling the coupling of mechanics and biochemistry in cell adhesion — •Achim Besser — Harvard Medical School, Department of Cell Biology, 240 Longwood Ave, Boston MA 02115, USA.

To probe the mechanical properties of their environment, adherent cells actively generate forces which are converted into biochemical signals at sites of adhesion. These biochemical signals diffuse into the cell and modify force generation, thus leading to a closed mechano-chemical feedback cycle. A dynamical systems analysis has been performed which demonstrates that this feedback cycle acts as a bistable switch that allows cells to discriminate between soft and stiff environments. We first present an analytically solvable mechanical model for the main force-generating element in adherent cells, so-called stress fibers, which are actin filament bundles contracted by myosin motors. Our model combines passive viscoelasticity with active contractility and shows excellent agreement with experimental data on stress fiber contraction dynamics after laser surgery. Next the stress fiber model is coupled to a reaction diffusion system describing the signaling pathway that is initiated at sites of adhesion. A bifurcation analysis reveals that the coupled system is bistable as a function of environmental stiffness. This should give rise to hysteresis in the cellular traction forces when cells are exposed to substrates of time-dependent stiffness.

Invited Talk SYDI 1.2 Tue 14:00 H10

Nitrogen Containing III-V Semiconductor Surfaces and Nanostructures Studied by Scanning Tunneling Microscopy and Spectroscopy — •Lena Ivanova — Technische Universität Berlin, Institut für Festkörperphysik

Different nitrogen containing III-V semiconductor surfaces and nanostructures are studied using scanning tunneling microscopy and spectroscopy. In so-called diluted GaAsN layers single nitrogen atoms can be identified on the GaAs(110) cleavage surface. The measured density of states shows that nitrogen impurities lead to a splitting of the GaAs conduction band. The incorporation of nitrogen with a nominal concentration of 9% into InAs/GaAs quantum dots leads to a strong dissolution and the formation of extended spherical nitrogen-free InGaAs quantum dots with a low indium content. Furthermore, for the GaN$(1\bar{1}00)$ cleavage surface of epitaxially grown GaN substrates it is found that both the nitrogen and gallium derived intrinsic dangling bond surface states are outside of the fundamental bulk band gap. The observed Fermi level pinning at 1.0 eV below the conduction band edge is attributed to the high step density, but not to intrinsic surface states. In GaN wafers dislocations are found to form localized bunches of entangled nonparallel dislocation lines. Within these bunches uncharged perfect dislocations with $a/3\langle 11\bar{2}0\rangle$ Burgers vectors and negatively charged Shockley partial dislocations with $a/3\langle 1\bar{1}00\rangle$ Burgers vectors interconnected by a negatively charged stacking fault are identified. Finally, an epitaxially grown silicon doping modulation structure is imaged.

Invited Talk SYDI 1.3 Tue 14:30 H10

Charge Transport in Organic Crystals — •Frank Ortmann — Friedrich-Schiller-Universität Jena, Institut für Festkörpertheorie und -optik, Jena, Germany — CEA Grenoble, France

The understanding of basic principles of charge transport in semiconductors with varying strength of electron-phonon interaction is still a great challenge. The complex interplay between moving electrons and phonons results in a variety of transport phenomena that evaded a comprehensive description within a single approach so far. Only for certain limits such as band transport in crystalline structures with weak electron-phonon coupling or phonon-assisted hopping in disordered systems with strong electron-phonon coupling one can easily come up with reduced models for carrier transport. This is not possible, however, for organic crystals which are important benchmark systems to understand carrier transport in organic materials.

I present a novel approach that describes carrier transport for arbitrary strength of the electron-phonon coupling including the temperature-dependent crossover from band transport to hopping in organic crystals. The polaronic nature and motion of localized carriers at high temperatures is obtained as well as the band motion for delocalized particles at low temperatures. The theory, supplemented with material parameters obtained from density-functional theory, allows for a systematic study of carrier transport in organic crystals. As a prototypical example, the simulated carrier mobilities for naphthalene crystals show clear improvements with respect to measured values both for the temperature dependence and for the mobility anisotropy.

Invited Talk SYDI 1.4 Tue 15:00 H10

Quantum transport in nanostructures: from numerical algorithms to spintronics in graphene — •Michael Wimmer — Institut für Theoretische Physik, Universität Regensburg, Germany — Instituut Lorentz, Universiteit Leiden, The Netherlands

When device dimensions become comparable to the phase coherence length of electrons, quantum effects lead to a vast number of different transport phenomena. In this talk, I will focus on two aspects of quantum transport: numerical algorithms to calculate quantum transport properties, and the generation of spin currents in graphene.

In principle, there are well-established theoretical frameworks for the numerical calculation of quantum transport properties. However, the application of these frameworks to a specific system faces difficulties that often are solved individually for each problem. I will highlight these difficulties and present generic solutions that allow for the solution of quantum transport problems in *arbitrary* systems.

Making use of these numerical techniques as well as analytical models, I will then discuss the generation of spin currents in graphene. Graphene nanoribbons oriented close to the "zigzag" direction support edge states that have been predicted to be magnetic. I will show how edge roughness can be used to generate a finite spin conductance. The effects of phase coherence also lead to a universal value of the spin conductance fluctuations. A finite spin conductance is a prerequisite for spintronics applications, and may also serve as an all-electrical detection method of the edge magnetism in graphene that has been elusive experimentally so far.