dot in the channel with a charging energy as well as a level spacing consistent with a 2 nm wide channel that extends from source to drain. These FinFETs are not only relevant as future MOSFETs, since the formation of an ultra-small edge channel due to the triple-gate geometry is also very interesting for fundamental physics, e.g. to study a single impurity in a semiconductor.

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WeA2p.15 16:30 Poster

Modelling Random Resistive Memory Devices — MARCELO J. ROZENBERG[1], ISAO H INOUE[2], and •MARÍA J. SÁNCHEZ[3] — [1]Laboratoire de Physique des Solides, UMR8502, Université Paris-Sud, Orsay 91405, France — [2]Correlated Electron Research Center (CERC), AIST, Tsukuba 305-8562, Japan — [3]Centro Atómico Bariloche and Instituto Balseiro , (8400), San Carlos de Bariloche, Argentina

There is a current upsurge in research on nonvolatile two-terminal resistance random access memory (RRAM) for next generation electronic applications. The RRAM is composed of a simple sandwich of a semiconductor with two metal electrodes. In this talk we shall: (i) review some of the essential features associated with RRAM behavior, such as hysteresys and multilevel resistance switching. (ii) introduce a basic model for RRAM with the made assumption that the semiconducting part has a non-percolating domain structure. (iii) present and discuss the behavior of the model investigated with numerical simulations that allows to understand the carrier transfer mechanisms in detail, and see how our model captures three key features observed in experiments: multilevel switchability of the resistance, its memory retention and hysteretic behaviour in the current-voltage curve. A very interesting aspect of our investigations is that they suggest that strong correlation effects are crucial for important resistance switching features.

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WeA2p.16 16:30 Poster

Modeling of Electron Transport in GaN-based Materials and Devices — •STANISLAV VITANOV[1], VASSIL PALANKOVSKI[1], RUEDIGER QUAY[2], and ERASMUS LANGER[1] — [1]Inst. for Microelectronics, TU Vienna, Gusshausstr. 27-29, Vienna, Austria — [2]Fraunhofer Inst. for Solid-State Physics (IAF), Tullastr. 72, Freiburg, Germany

AlGaN/GaN based high electron mobility transistors (HEMTs) have been subject of extensive investigations in the last years. Their performance makes them suitable for power amplifiers in infrastructure base station applications. In order to fully develop the potential of the device, an accurate simulation model is needed.

Material models which incorporate the basic characteristics of the underlying physics in a given semiconductor material are the core of device modeling. We employ a Monte Carlo technique to investigate stationary electron transport in GaN and AlGaN [1]. A special approach on the piezoelectric scattering mechanism taking care of the hexagonal crystal structure is used. We obtain a set of model parameters which gives agreement with experimental data available for different physical conditions (doping, temperature, field, etc.). Such a calibrated set of models and model parameters delivers valuable data for low-field mobility, velocity saturation, energy relaxation times, etc.

We use these data as a basis for the development of analytical models for the numerical simulation of GaN-based electron devices. As a particular example we analyze an AlGaN/GaN HEMT with l_g=600 nm from IAF using the two-dimensional device simulator Minimos-NT [2]. We study the penetration depth of the drain/source metal contacts which may build an alloy with the AlGaN supply layer. In order to properly describe the two-dimensional electron gas in the channel, the value of the positive polarization charge density at the AlGaN/GaN interface is assessed. Since the longitudinal electric field in the channel reaches peak values of above 500 kV/cm, a hydrodynamic approach is used to properly model the electron transport and energy relaxation. We further assess the impact of thermionic emission and field emission (tunneling) effects which critically determine the current transport across the heterojunctions.

Our results allow not only to get a good agreement between simulation and measured electrical data, but to gain understanding and insight in the effects taking place in the device.

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WeA2p.17 16:30 Poster

Quantum Non-Locality in Systems with Open Boundaries: Limitations of the Wigner function formalism — •DAVID TAJ[1,3], LUIGI GENOVESE[2], and FAUSTO ROSSI[1] — [1]Dipartimento di Fisica, Politecnico di Torino, 10129 Torino, Italy — [2]Dipartimento di Fisica e Sez. INFN, Università di Roma "Tor Vergata", 00133 Roma, Italy — [3]Dipartimento di Matematica, Università di Torino, 10123 Torino, Italy

Current micro/nanoelectronics technology pushes device dimensions toward limits where the traditional semiclassical Boltzmann theory can no longer be applied, and more rigorous quantum-transport approaches are required, in which a non-trivial interplay between phase coherence and dissipation/dephasing, also induced by the spatial boundaries forces a real-space treatment.

Such a real-space description is naturally provided by the Wigner-Function Formalism (WFF) in which the statistical quantum state of the electronic subsystem is fully described in terms of the Wigner function, defined over the phase-space as the Weyl-Wigner transform of the single-particle density matrix.

Different approaches based on the WFF have been proposed. On the one hand, starting from the pioneering work by Frensley, a few groups have performed simulations based on a direct numerical solution of the Wigner Transport Equation (WTE) by imposing the standard boundary-condition scheme of the semiclassical device modelling, also called **U**-scheme.

On the other hand, recent applications of a generalization of the well-known Semiconductor Bloch Equations (SBE) suggested an intrinsic limitation of the conventional WFF in describing quantum-transport phenomena through systems with open boundaries, but no clear evidence of them has been reported so far via numerical WTE simulations.Aim of this work is to solve this apparent contradiction, thus shedding light on the real limitations of the conventional WFF applied to open-device modelling.

We consider the one dimensional WTE in stationary conditions and in the absence of scattering mechanism: in total agreement with the numerical results of the generalized SBE presented in, we prove that, for any symmetric potential profile, the spatial charge density is always symmetric, no matter which is the shape of the injected carrier distribution. Since, however, such symmetric behavior has never been observed via finite-difference calculations as computed in, we further investigate this contradiction by analytically solving the WTE for the particular case of a cosine-like device potential profile: we show that the difference between our analytical results and the finite difference approach is due to a misalignment of the kinetic and the potential terms in the discretisation process. Indeed, by correcting for the latter, we recover our analytical result. Moreover, even with extremely simple spatial boundary conditions (monoenergetic and unilateral carrier injection), we are immediately faced with a symmetric spatial density which is non negligibly negative. This leads us to our main result: the analytical solution of the Wigner transport equation in systems with open boundaries is not necessarily a Wigner function, that is, the artificial spatial separation between device active region and external reservoirs is intrinsically incompatible with the non-local character of quantum mechanics [1].

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