Poster Chair Transport & field emission session NT06

POSTER SESSION F
Transport Properties & Field Emission
58 Posters

Stephan Roche
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Fundamental properties: Theory and Experiments
(at the single CNT scale, or assemblies)

20 Posters

Material research and application oriented

38 Posters
Topics

Fundamental studies

- **Deeper understanding of transport in low dimensionality**
- **New physics** (« exploring new rooms at the bottom »)

- Transport coherent regime (noninteracting models)

- Electron-electron interactions (beyond noninteracting models)

- Electron-phonon coupling

- Charge injection at metal/nanotube interface & device simulation

- Effect of chemical doping, functionalization

Toward applications

- **Improving device performances**
- **Adding new functionalities to CMOS**

- Interconnects

- Field effect transistors

- Field emitters

- Other CNT-based components
In-depth exploration of low dimensional intrinsic transport

**F.014:** 4-p resistance of individual SWNT using MWNTs
B. Gao et al

*Using MWNTs as noninvasive voltage probes in 4p measurements: intrinsic resistance & observation of negative four-terminal resistance at He temperature*

**F.024:** Towards integrating CNT with low dimensional electron devices in GaAs
P. Scard et al.

*New device to investigate low-dimensional transport 2DEG to gate the tube and vice-versa*

**F.006:** Charge transport in CNT driven by surface acoustic waves
V. Siegle et al
**Exploration of contact effects & related phenomena**

**F.053: Magnetoconductance of CNT with ferromagnetic contacts**
E. Pallechi et al

*Magnetic properties of PdFe contacts (Lorentz microscopy & squid magnetometry)  
TEM characterization of CNTs + Magnetoresistance measurements (hysteretic switching,...)*

**F.001: Electronic transport of SWNT/GaAs junction**
C.W. Liang and S. Roth

*Contact & charge transfer issues : p-type GaAs = ohmic  n-type GaAs: rectifying*

**F.004: Electronic transport in CNTs: from single CNTs to thin & thick networks**
V. Skalalova et al

*Phonon backscattering and T-dependent conductance  
Transition from hopping to metallic conduction as a function of network thickness*

**F.029: Experiments on electron transport in MWNTs**
K. Yoshii et al

*Transport comparison between free standing and supported tubes*
Beyond noninteracting electron models

F.021: Observation of magnetization drop in superconductive MWNTs
J. Haruyama et al

Superconductivity at 12K!

Superconductivity vs Luttinger Liquid
-the contact issue-

F.019: Multiple Andreev reflections and re-entrant behavior in Network-like carbon nanotubes
YL Zhong et al (NTT Basic Research Labs)

Magnetoconductance oscillations
=Andreev quasiparticle interferences

F.028: Electrical characterisation of free standing MWNTs
P.R. Smith et al. 

$I \propto V^{\alpha+1}$ with large exponent=5

Relate environmental CB fluctuations & high frequency impedance of freestanding geometry
Theory & simulation: device modeling

F.007: Electromigration Forces on Ions in Carbon Nanotube Transistors
N. Wang, S. Heinze, and J. Tersoff

Current-induced forces \((V_g)\) on ions located outside or inside tubes (limitations of Alkali doped CNT-FETs)

F.020: First principles study of charge transport across CNT-metal contacts
NY-H Kim

F.027: Simulation of CNT-metal-Semiconductor On-Tube Heterojunction
S. Sukirno et al

F.056: Extended Contacts to CNT Devices: Role of Geometry & Quality of the Electrodes
N. Nemec, D. Tomanek, and G. Cuniberti

Microscopic ab-initio study of metal/CNT interface, and extraction of tight-binding parameters by fitting hybridization in bandstructure

Pd binds weaker than Ti but allows for better transmission...
Exploring e-p in transport studies?

- New physics beyond semi-classical models (applicability range of FGR and Boltzmann like approaches, decoherence and out-of equilibrium transport, non perturbative (many-body) treatment of e-p coupling,...

- Understanding performance limitations of CNT-FETs, tackling dissipation issues in devices

F.009: Intraband electron-phonon matrix elements on SWNT
V. Popov and Ph. Lambin

Chirality dependence of electron-phonon backscattering rules
Novel directions in electron-phonon transport

F.002: Influence of phonon defect scattering on thermal transport in CNTs
T. Yamamoto and K. Watanabe

Low-T: quantization of thermal Conductance in CNTs (even if defective)
High-T: localized vibrations around defects scatter incident phonons
(quantum-classical features with increasing T)

F.010: Phonon-assisted tunneling in interacting suspended SWNT
W. Izumida and M. Grifoni

Low-energy spectrum of interacting electrons (LL) coupled acoustic modes

F.023: Hot phonon generation in CNT under electronic transport
F. Mauri and M. Lazzeri

Ab-initio Fermi Golden rule and inelastic MFP

F.003: Quantum dephasing and decoherence in CNTs: Role of e-p coupling
S. Roche et al

Strong impact of optic/ZB modes on conductance, limits of FGR for CNT-FET device simulation
Electromechanical effects

**F.011: Electromechanical instabilities in suspended CNTs**
M. Jonsson et al

*Mechanical instability:*
*Coupling between vibrational modes of CNT & tunneling electrons yields a pumping of energy into the mechanical system (increase amplitude of vibrations)*

**F.025: Quantum multi-connectivity in phase coherent transport**
M. Jonsson et al

*In a transverse magnetic field (suspended SWNT) coupling between electronic & vibronic states yields negative SWNT magneto-conductance (10 mK, 10 T). Detection of nanomechanical SWNT vibrations in the quantum regime*

**F.022: Electronic conduction in metallic CNTs under external strain**
N. Yonezawa and H. Suzuura

*Sensitivity to disorder in metallic SWNT is enhanced under external stress*
Should we believe in CNT-mediated Nanosensing?

Ultimate sensitivity and selectivity potentialities (adding functionalities to CMOS)

Electrical detection of proteins interactions
pH, enzymatic activity,…
Virus, gas,…

F.026: Modeling the effect of dispersed doping agents in CNTs
C.G. Rocha et al

*Ab initio + TB to tackle with transport of random coverage of dopants*

But more in E and G sessions…
Theory : last but not least!

\[ \psi \sim e^{ik_y y} e^{ik_x x} \times e^{i \frac{e}{\hbar} \int \vec{A} \cdot d\vec{r}} \]

\[ k_x = \frac{2\pi q}{|C_h|} + \frac{2\pi \Phi}{\Phi_0} \]


**F.030 Aharonov-Bohm effects on Boltzmann conductivity in CNTs**
T. Nakanishi and T. Ando

*Strong magnetoconductivity fingerprints*
**Toward applications**

**CNT-based interconnects in Nanoelectronics:**

*Potential and Roadmap for technological transfer?*

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**F.013:** LSI via interconnects made of MWNTs grown from Co nanoparticles

S. Sato et al (Fujitsu)

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**F.017:** CNTs interconnection for full 6-inch integration

S. Lee et al. (SAMSUNG)

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Crucial role of good annealing process to reduce

Contact resistance

CNT-via module implemented into conventional
manufacturing process with compatibility

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**I(V,Temp)**

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Exploring electrical current capability limits of CNTs

**F.008: Current breakdown & transport measurements on individual MWNTs**
L. Hao et al.

- *Ballistic transport for both electron and phonons at RT. Current densities = $10^{14}$ A/m$^2$*
- *Electrical breakdown occurs at very high powers (~18mW) and currents (~7.6mA) and at the defects*

**F.005: Electrical conductance & breakdown in individual CNx MWNTs**
H.J. Burch et al.

- *AFM method to measure conductances, I-V curves and wall-by-wall breakdown of CN$_x$ MWNTs.*

**F.016: Current induce improvement of contact resistance between CNT & Pt electrode**
Y. Yoshikawa et al.

**F.055: In situ Study on Migration of Metals on CNT surfaces induced by electric currents**
Y. Suzuki et al.
CNT-based Field Emission?

Getting structural and electronic informations from field emission patterns

Designing novel CNT-based emitters for improving Field emission display applications and nanolithography
Field-emission investigation at the single CNT scale

F.036: Thermal annealing effect on field emission properties of double-walled carbon nanotubes
S. I. Jung et al,

CVD-grown & purified DWNTs used to fabricate field emitters
Improvement of performance after annealing treatment

Dynamic behavior of an open CNT emitter
Modeling of influence of geometrical parameters on FE

**F.035:** Effect of series resistance on current saturation in FE property of nano-carbon emitter  
K. Kamimura et al

**F.041:** Effects of pentagons arrangements on field emission patterns of capped nanotubes  
M. Khazaei et al

**F.044:** Enhancement factor of the electric field around a metallic, end-capped cyling  
M. Sveningsson et al.

Experiments on the influence of geometrical parameters of FE

**F.034:** Field emission property of a standalone CNT encapsulated with Fe  
L. Pan et al (OSAKA gas Co., Ltd)

**F.037:** Field emission characteristics of SWNT and DWNTs attached to AFM tips using dielectrophoresis method  
S.H. Jo et al

**F.051:** Stable MWNTs electron emitter for Scanning Electron Microscope  
T. Shimizu et al (TECHNEX Lab)

**F.054:** FEM and in situ TEM studies of CNT field emitters  
Y. Saito et al
F.031: Encapsulated vertically grown CNTs for submicron and Nanolithography
A.M. Miri et al

- A novel method of nano-lithography using electron emission of encapsulated nickel seeded carbon nano-tubes (PECVD) grown on Si substrate.

F.033: Investigation of Nanoimprint lithography for the fabrication of CNT field emitters
S. Vieira et al (THALES)

- dc-plasma CVD growth of MWNTs and nanoimprint lithography to massively and cost-efficiently produce cathodes on a large wafer scale
- Optimizing spacing between CNT emitters to reduce screening effects

F.048: Fabrication of CNTs field emitter using a dip coating method
Y I Song et al (SAMSUNG)
Material research (large scale integration)

F.012: A simple suspension of single MWNT based on a deep trench electrode
C-S. Han et al

F.032: Effect of graphitic order on the electron field emission stability of CNTs
Y.K. Yap et al

F.036: Thermal annealing effect on field emission properties of DWNTs
S. I. Jung

F.038: Investigation of field emission from MWNTs yarn
S.H. Jo et al

F.039: Characterization of field electron emission using exfoliated carbon fibers
M. Toyoda et al (SAKAI OVEX Co. Ltd)

F.040: Highly aligned Magnetic particles functionalized SWNTs by magnetic fields
S.C. Youn et al

F.042: Enhanced field emission characteristics of CNTs nanofibers on glass substrates by plasma treatment and multi-stage growth process
S.M. Sung et al

F.043: Double-gated field emitter array with self-aligned CNTs grown by vapor deposition
MH Kim et al (SAMSUNG)

F.045 Field Emission properties of CNTs and carbon fibers prepared by thermal CVD
T.Y. Tsai and N.H. Tai

F.046: Field emission of CNTs grown by thermal CVD and etched back by dc plasma
HJ. Cho et al

F.047: CNT-based components for high frequency (Ghz) sources and sensors
H.M. Manohara et al

F.049: Electron emission of CNTs/polymer
S.G Yu et al (SAMSUNG)

F.050: Field emission properties of CNT/conducting polymer composite prepared by electrophoresis
E. Itoh and K. Miyairi

F.052: Simulation Study of the beam focus effect for CNT emitter based X-ray source
W. Chang et al
F.057: Building covalent 2D and 3D Networks from 1D Nanostructures
Jose M. Romo-Herrera et al

- CNT-based novel model architectures
- Electronic and mechanical properties

F.039: Characterization of field electron emission using exfoliated carbon fibers
Toyoda et al

- Exfoliated Carbon fibers
- FED electrodes
« …Enlightenment can not exist apart from ignorance, nor ignorance apart from Enlightenment. Such things do not differ in nature, there can be no duality… »

(The teaching of Buddha)

Thank you for attention and please

ENJOY THE POSTER Session  !!!!