POSTER SESSION F

Transport Properties & Field Emission

58 Posters

Stephan Roche
CEA/DSM/DRFMC/SPSMS/Groupe Théorie
stephan.roche@cea.fr

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 »)

4 *Transport coherent regime (noninteracting models)*

4 *Electron-electron interactions (beyond noninteracting models)*

7 *Electron-phonon coupling*

4 *Charge injection at metal/nanotube interface & device simulation*

1 *Effect of chemical doping, functionalization*

Toward applications

Improving device performances
Adding new functionalities to CMOS

7 *Interconnects*

8 *Field effect transistors*

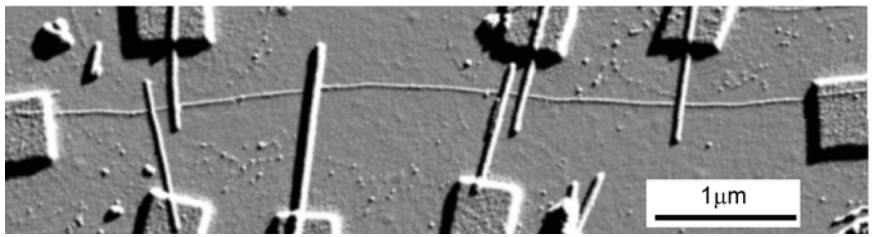
20 *Field emitters*

3 *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

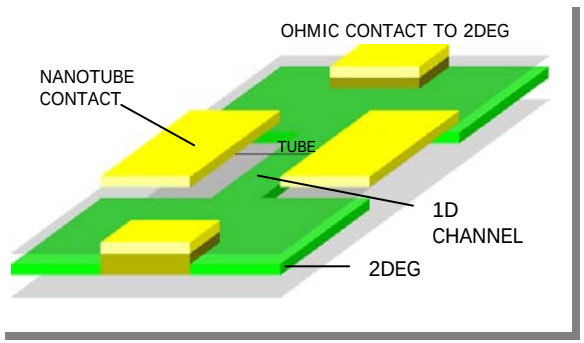


Using MWNTs as noninvasive voltage probes in 4p measurements : intrinsic resistance & observation of negative four-terminal resistance at He temperature

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 + Magnetoreistance 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

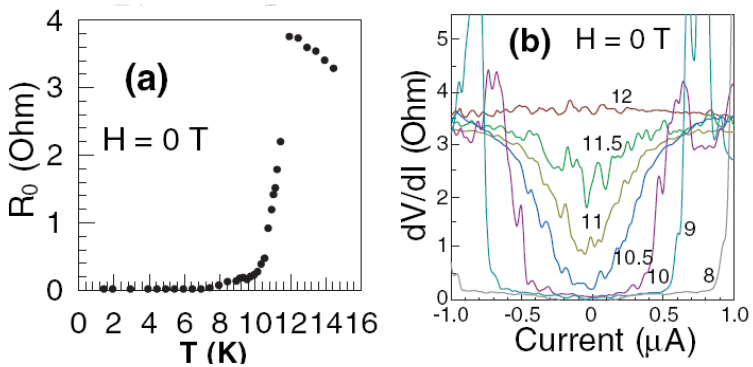
Beyond noninteracting electron models

F.021: Observation of magnetization drop in superconductive MWNTs

J. Haruyama et al

Superconductivity at 12K !

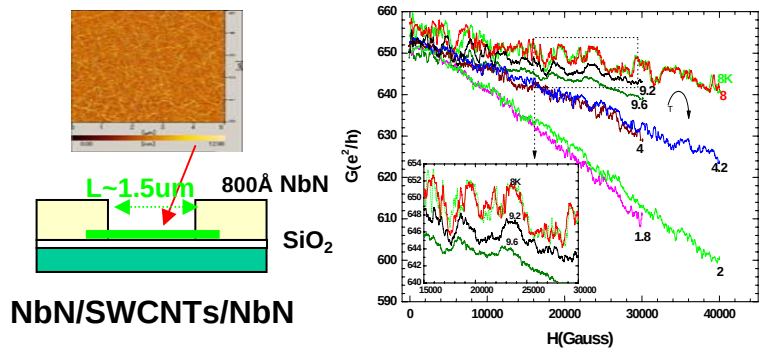
Superconductivity vs Luttinger Liquid
-the contact issue-



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

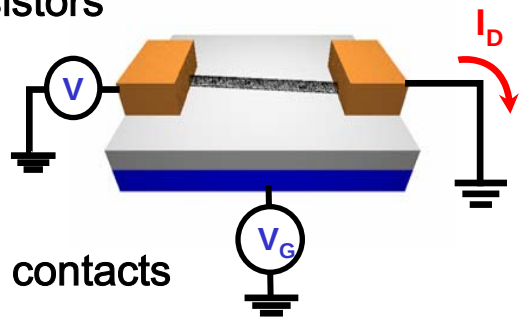
P.R. Smith et al.

$I \propto V^{\alpha+1}$ 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 (Vg) on ions located outside or inside tubes (limitations of Alkali doped CNT-FETs)

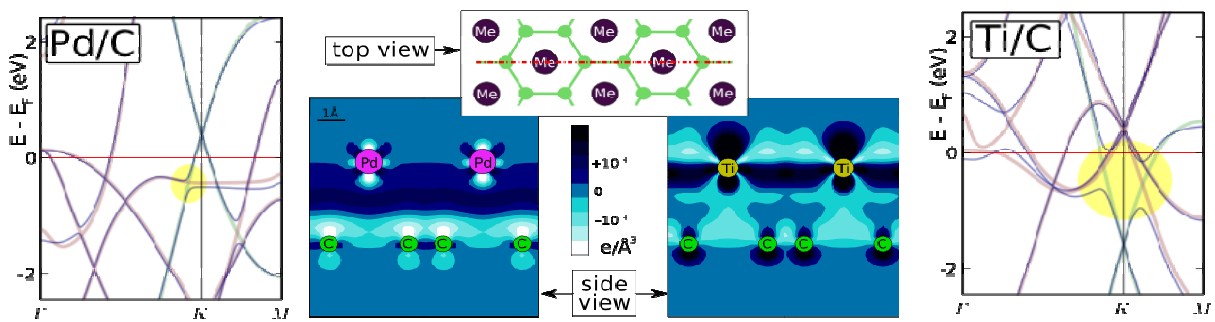


F.020: First principles study of charge transport across CNT-metal contacts
NY-H Kim

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

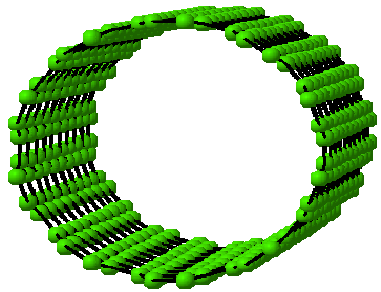


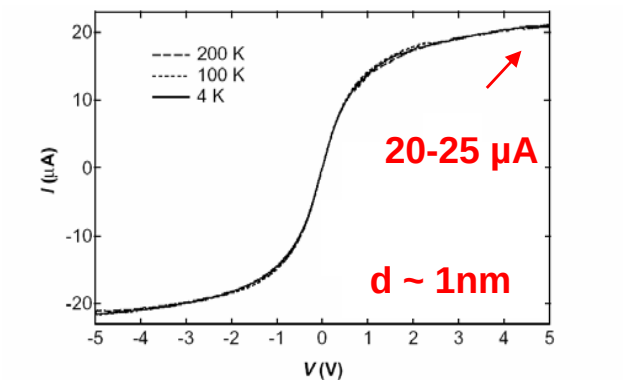
Pd binds weaker than Ti but allows for better transmission…

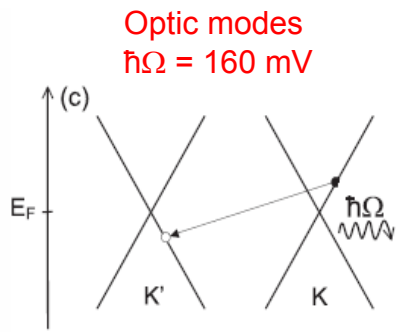
Exploring e-p in transport studies?

*-) **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

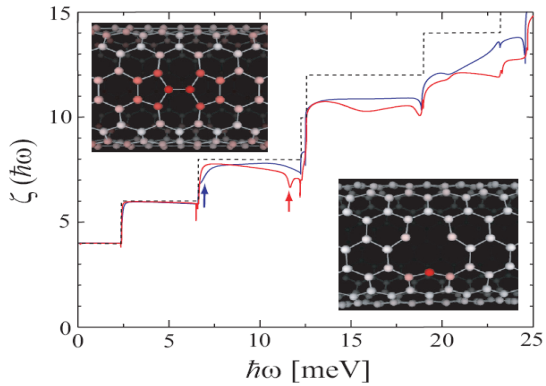
Chirality dependence of electron-phonon backscattering rules

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

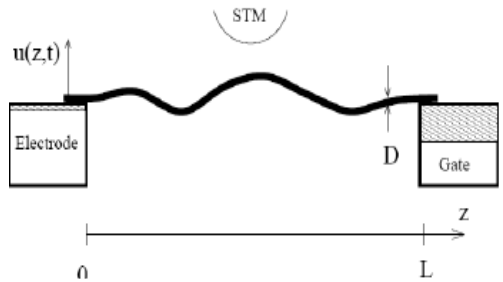
Strong impact of optic/ZB modes on conductance, limits of FGR for CNT-FET device simulation

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. Jonson et al

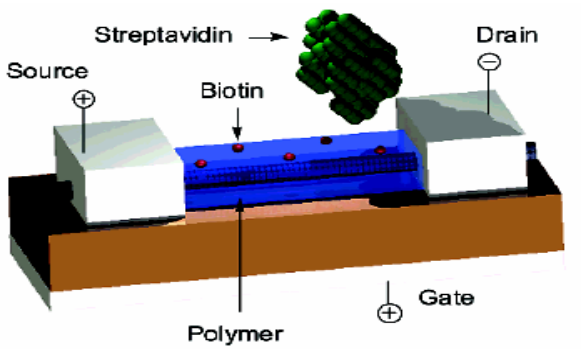
In a transverse magnetic field (suspended SWNT) coupling beween electronic & vibronic states yields negative SWNT magneto-conductance (10 mK, 10 T) .
Detection of nanomechanical SWNT vibrations in the quantum regime

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 proteines interactions
pH, enzymatic activity,…
Virus, gas,…

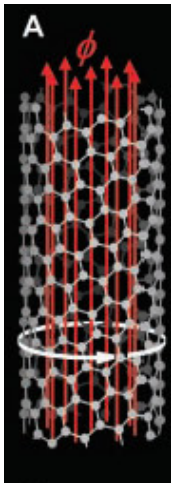
F.026: Modeling the effect of dispersed doping agents in CNTs

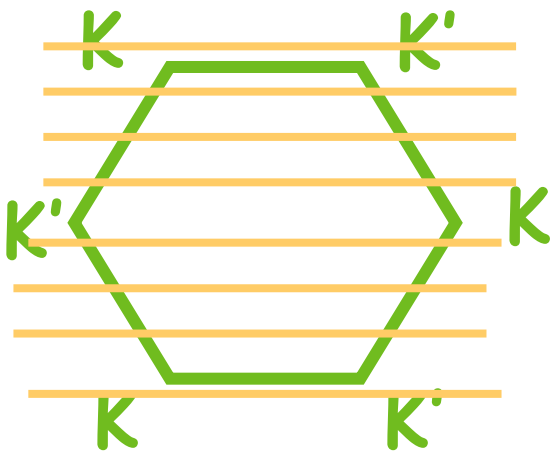
C.G. Rocha et al

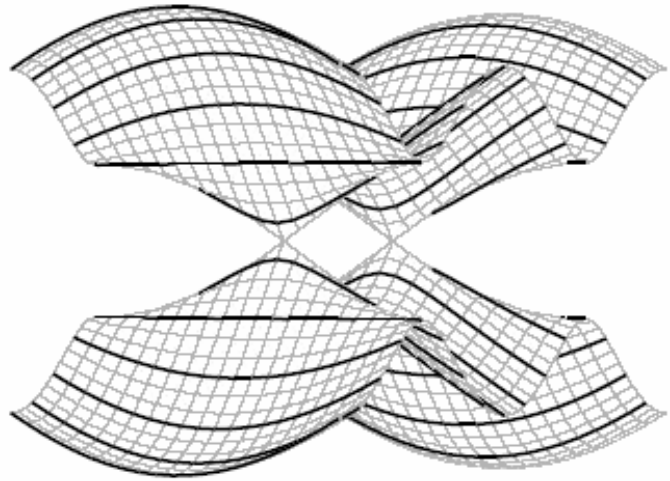
Ab initio + TB to tackle with transport of random coverage of dopants

But more in E and G sessions…

Theory : last but not least!







$$\Psi \sim e^{ik_y y} e^{ik_x x} \times e^{i\frac{e}{\hbar}\int \vec{A}.d\vec{r}}$$

$$k_x = \frac{2\pi q}{|\mathcal{C}_h|} + \frac{2\pi\Phi}{\Phi_0}$$

H. Ajiki and T. Ando, **J. Phys. Soc. Jpn 62,1255 (1993)**

S. Zaric et al;
Science 304, 1129 (2004)
U. Coskun et al.,
Science 304, 1132 (2004)

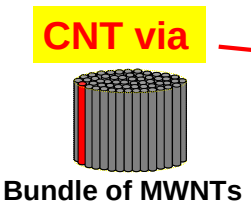
F.030 Aharonov-Bohm effects on Boltzmann conductivity in CNTs
T. Nakanishi and T. Ando

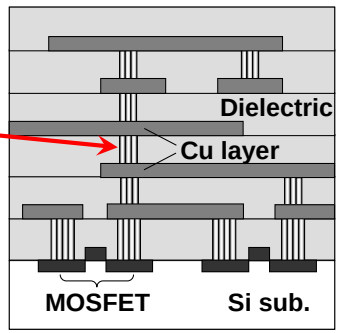
Strong magnetoconductivity fingerprints

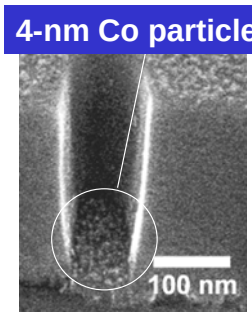
CNT-based interconnects in Nanoelectronics:

Potential and Roadmap for technological transfer ?

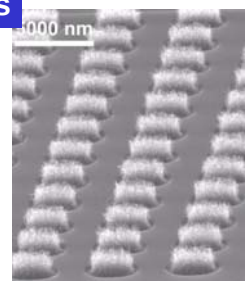
F.013: LSI via interconnects made of MWNTs grown from Co nanoparticles
S. Sato et al (Fujitsu)



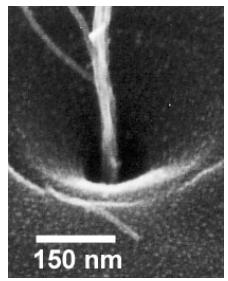




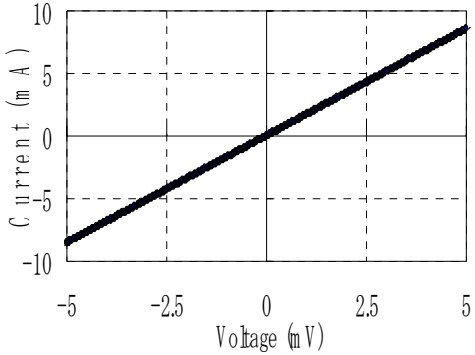
CNTs from 2-μm via holes



CNTs from a **40-nm** via hole

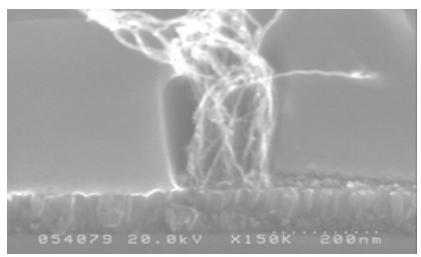


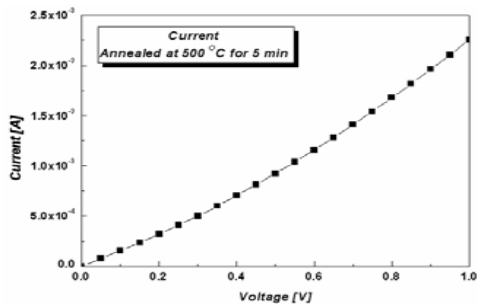
I(V,Temp)



F.017: CNTs interconnection for full 6-inch integration
S. Lee et al. (SAMSUNG)

Crucial role of good annealing process to reduce Contact resistance
CNT-via module implemented into conventional manufacturing process with compatibility





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

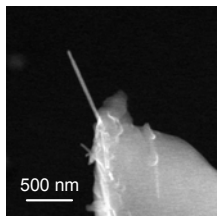
F.005: Electrical conductance & breakdown in individual CNx MWNTs
H.J. Burch et al.

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 ?

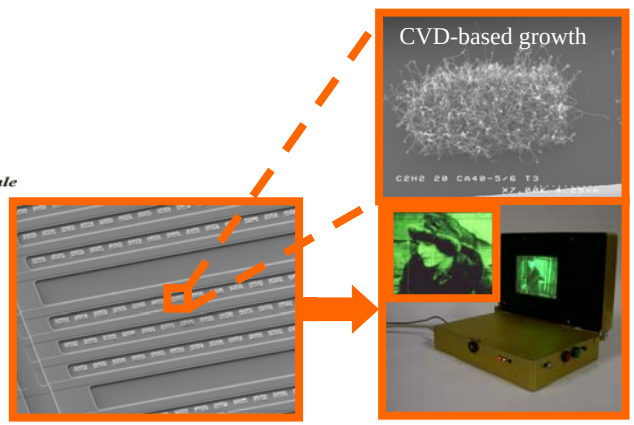


Getting structural and electronic informations from field emission patterns

8 Posters

Designing novel CNT-based emitters for improving Field emission display applications and nanolithography

Silver Award:
ISE's Carbon-Nanotube FED Module



CEA-LETI

Samsung

12 Posters

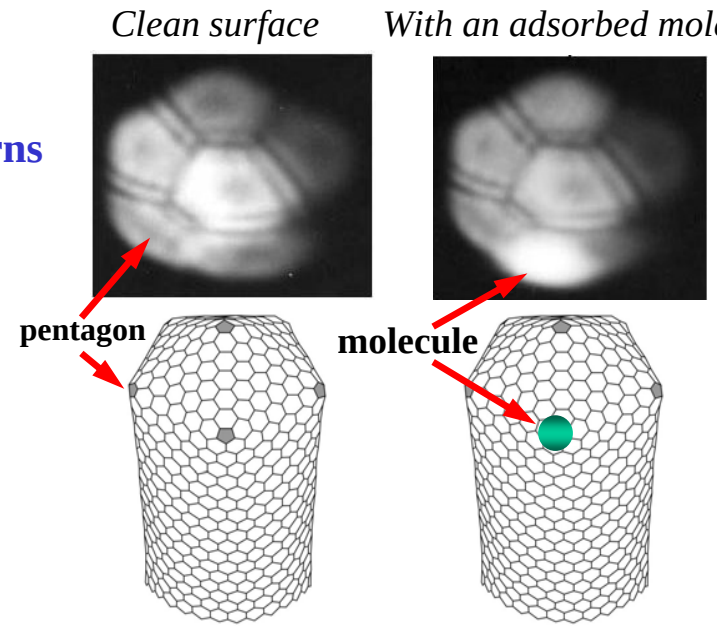
Structural & electronic informations from FE patterns

Field-emission investigation at the single CNT scale

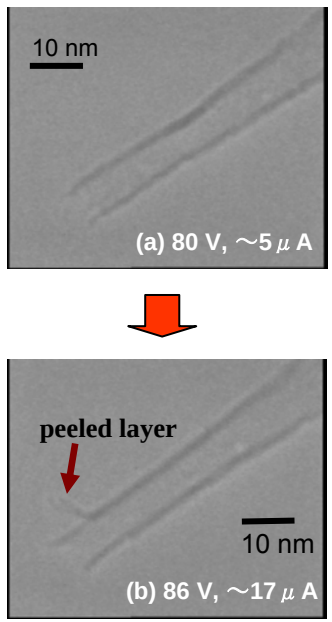
F.036:Thermal annealing effect on field emission properties of double-walled carbon nanotubes
S. I. Jung et al,

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

FEM patterns



Dynamic behavior of an open CNT emitter



Structural & electronic informations from FE patterns

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)

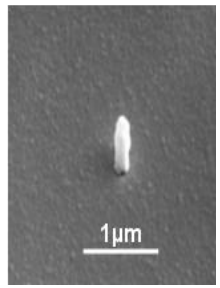
F.054: FEM and in situ TEM studies of CNT field emitters
Y. Saito et al

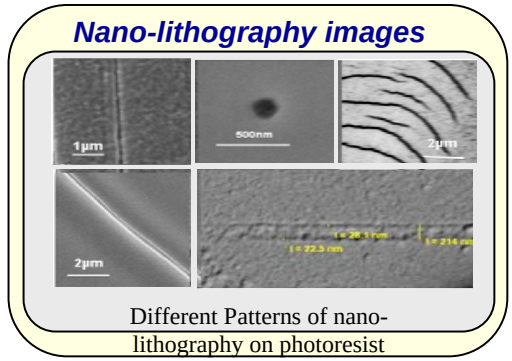
Material research (large scale integration)

F.031: Encapsulated vertically grown CNTs for submicron and Nanolithography

A.M. Miri et al

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





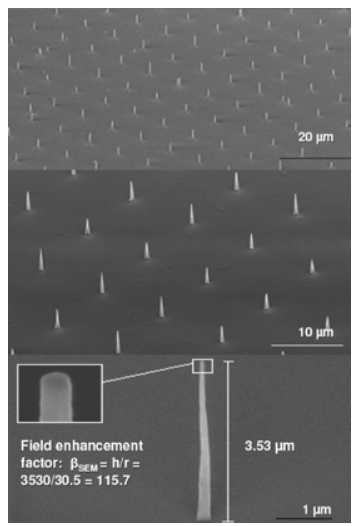
Different Patterns of nano-lithography on photoresist

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 & 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 emision 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 emision 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 !!!!