Electron Beam Lithography on Irregular Surfaces Using an Evaporated Resist

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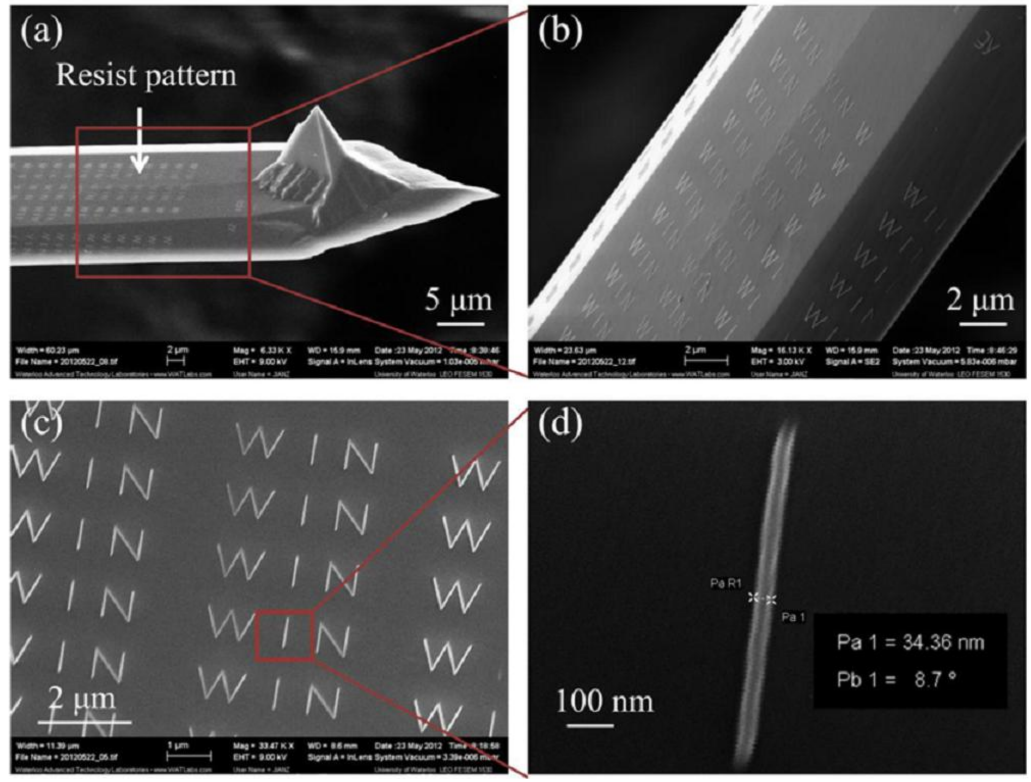
NanoJC

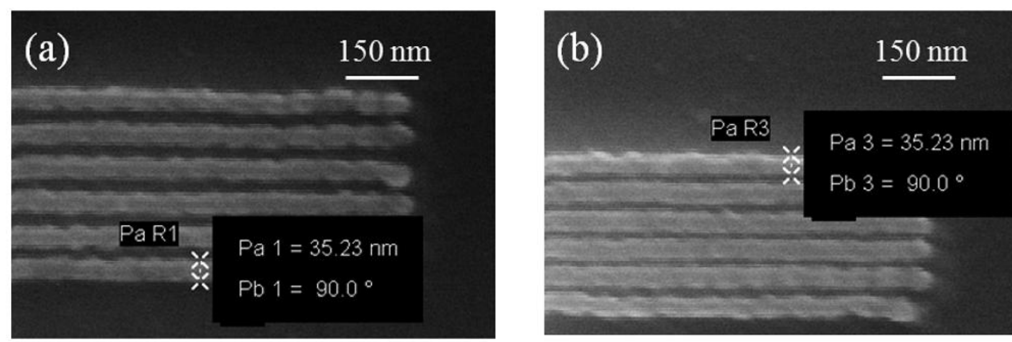
2014-04-08

MŰEGYETEM 1782

EBL with Evaporated Resist

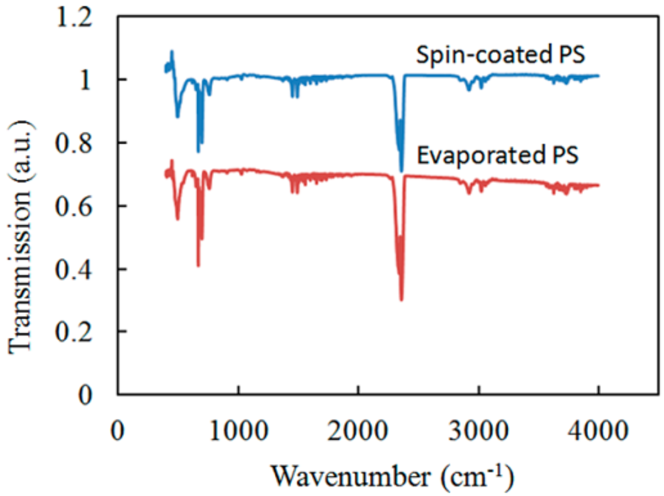
- Non-planar, irregular, fragile substrate
- optical fiber: lab-on-fiber technology
  - coupling to a metallic nanostructure
- resist deposition methods
  - spinning (low viscosity)
  - spray coating
  - Langmuir-Blodgett method
- previous approaches
  - Pedersen et al.: plasma-polymerized hexane
    low sensitivity, poor resolution (~150 nm)
  - Eric et al.: sterol resist named QSR-5
    moderate resolution, noncommercial resist
  - Daniel et al.: water vapor, ice formation
    special equipment, low sensitivity
  - similar issues with: CO_2, AlF_3, SiO_2

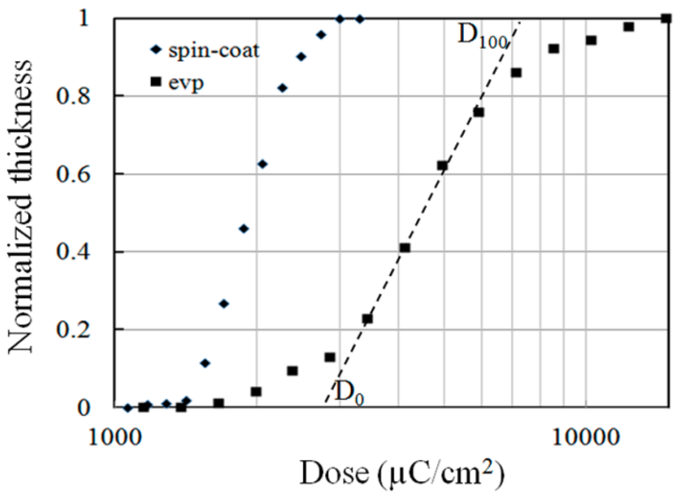




EBL with Evaporated Resist

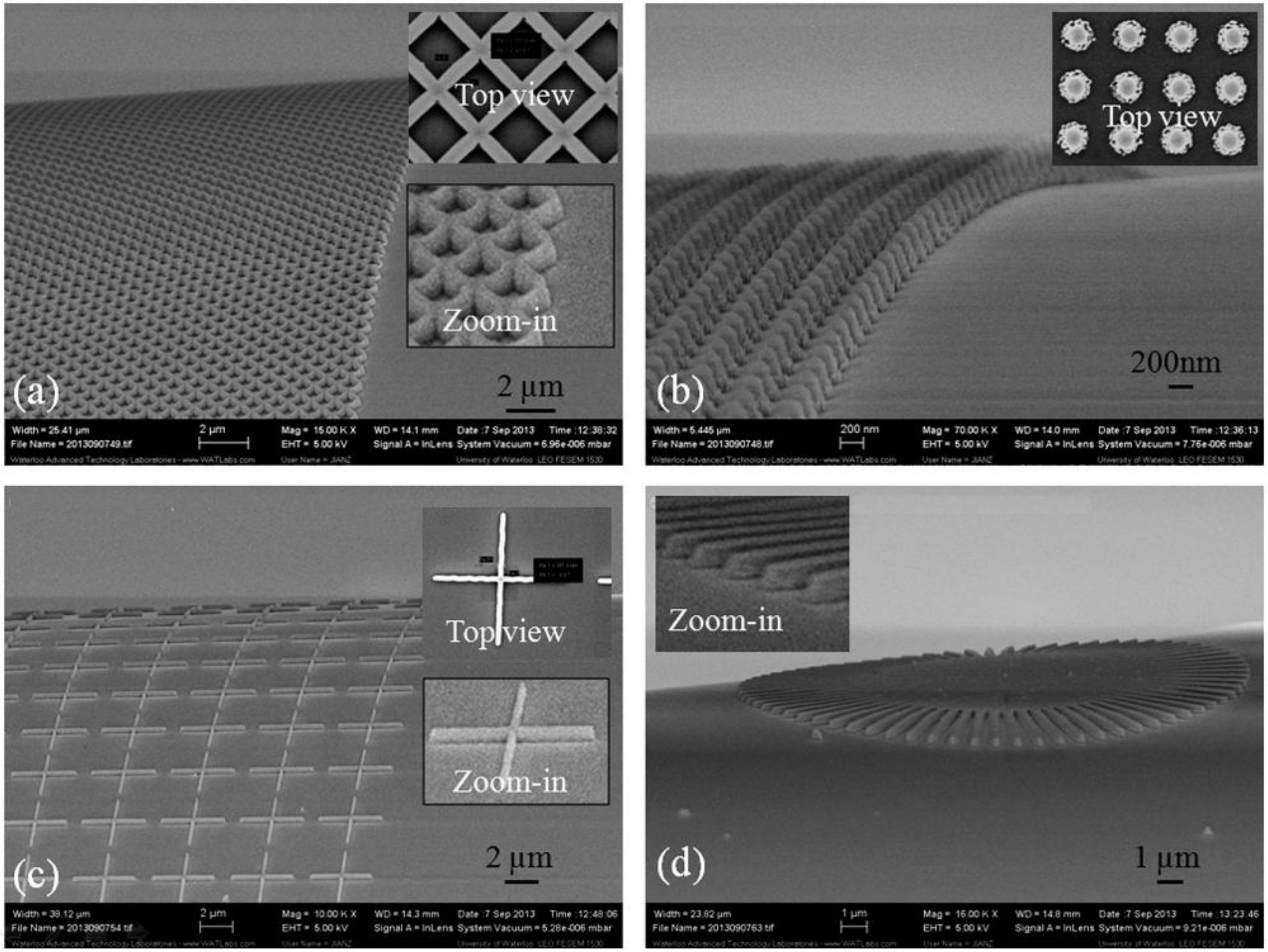
- new approach
  - low molecular weight polystyrene (PS)
  - sensitivity lower than PMMA's ~1 ueV/cm^2 @ 5keV
  - low dry etching rate
  - lack of edge bead effect (small wafers, e.g. single-crystal diamond)
  - precise control of film thickness
  - uniform coating (e.g. around dust particles)
  - negligible attack to the substrate material (e.g. a polymer susceptible to dissolution)
- resist parameters
  - roughness:
    spin coated: 0.239
    evaporated: 0.223
  - same IR spectrum → no chemical modification during evaporation
  - sensitivity:
    spin coated: 1920 uC/cm^2
    evaporated: 4500 uC/cm^2
    (lower molecular weight)





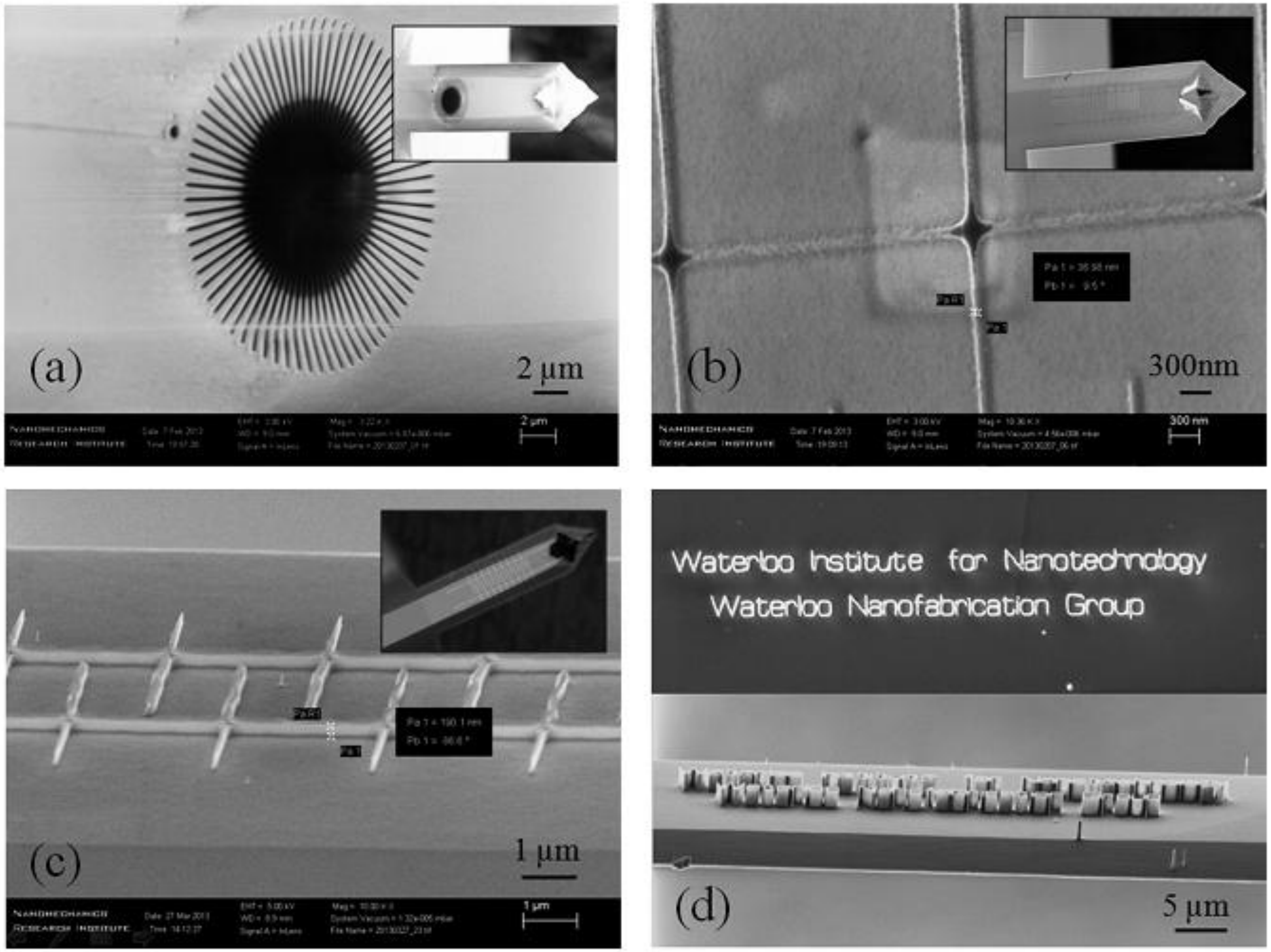
EBL with Evaporated Resist

- patterning an optical fiber



EBL with Evaporated Resist

- AFM cantilever



nature nanotechnology

LETTERS

PUBLISHED ONLINE: 23 MARCH 2014 | DOI: 10.1038/NNANO.2014.39

The effect of spin transport on spin lifetime in nanoscale systems

Jeremy Cardellino†, Nicolas Scozzaro†, Michael Herman, Andrew J. Berger, Chi Zhang, Kin Chung Fong, Ciriyam Jayaprakash, Denis V. Pelekhov and P. Chris Hammel*

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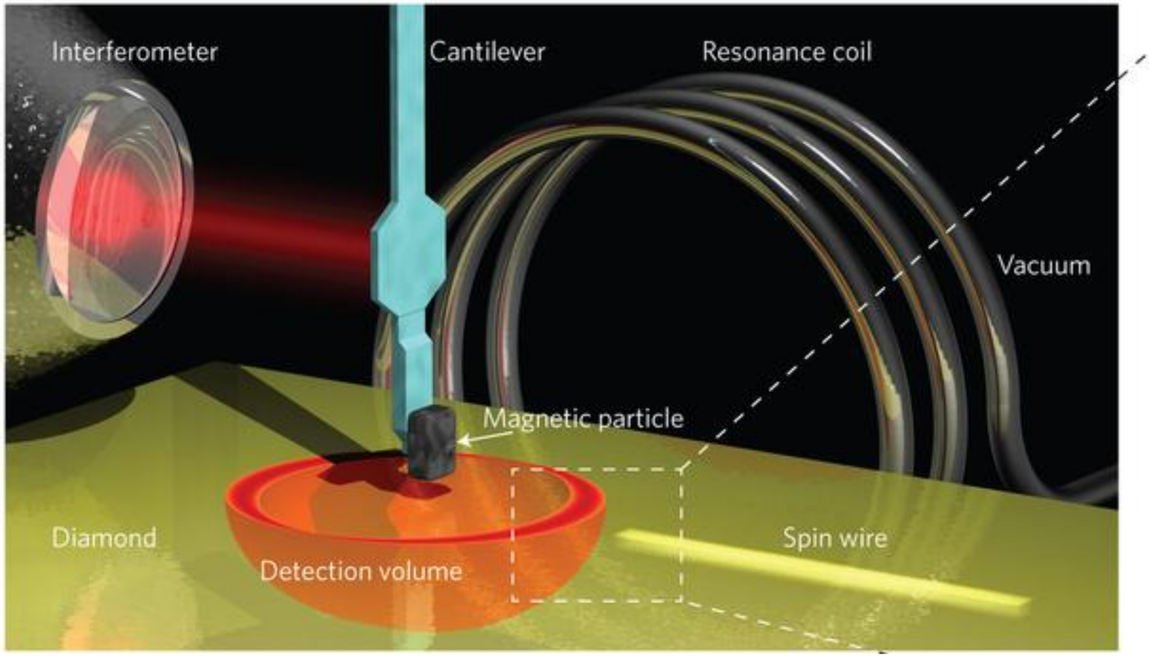
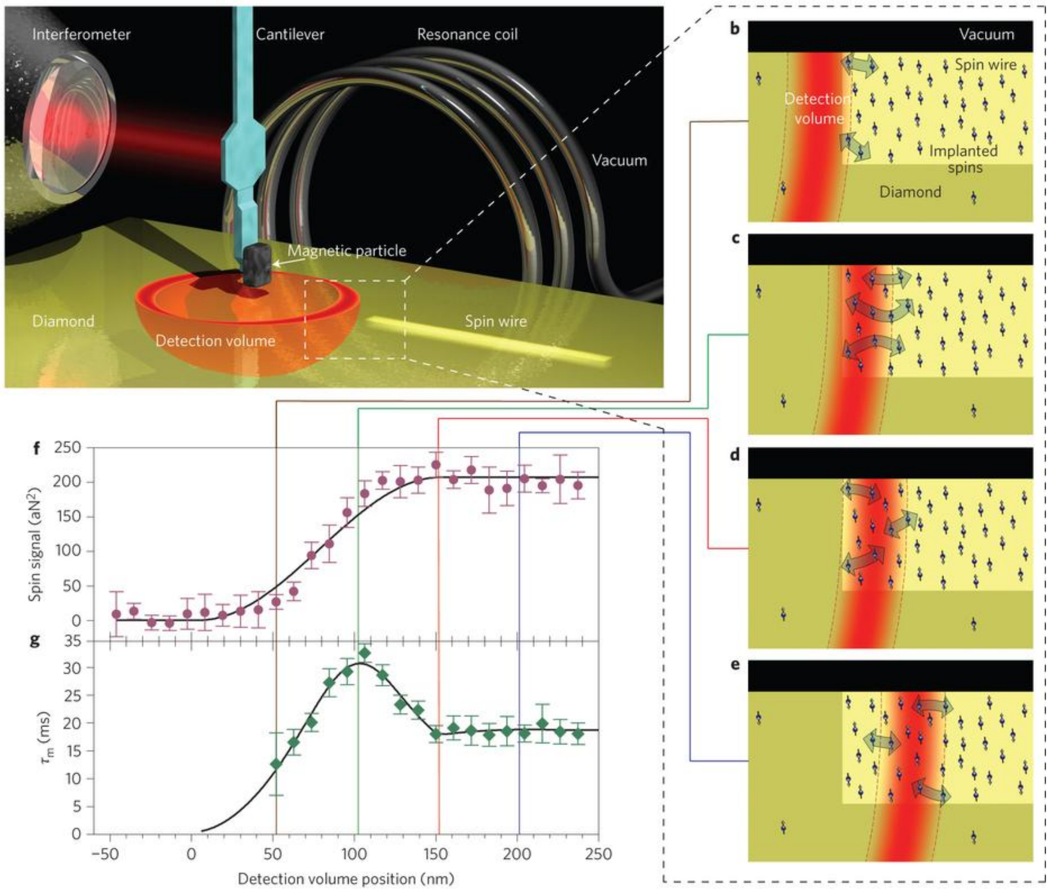
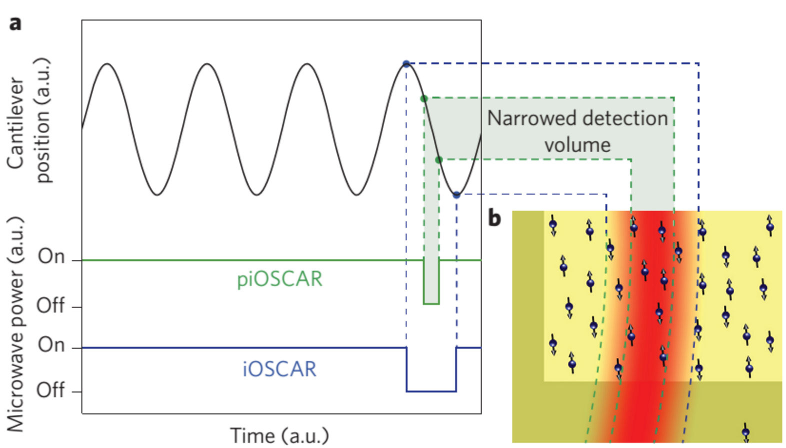


The effect of spin transport on spin lifetime in nanoscale systems

- magnetic resonance force microscopy (MRFM)[a]
- niobium coil: MW field, f = 2.18 GHz
- resonance field: B=77.8 mT
  (gyromagnetic ratio: 28 GHz/T)
- oscillating resonance slice
  → detection volume
- measurement of force on the cantilever
  → spin signal magnitude
  from the magnitude of variance in the time record, directly related to the number of measured spins
  → force correlation time
  describes the characteristic time for the net moment of the detected spins to decorrelate (spin transport, spin relaxation, etc.)





- force correlation time
- Monte Carlo simulation

flip-flop time T_{ff}=0.21 ms
spin diffusion length L = 700 nm

PRL **112,** 126805 (2014) PHYSICAL REVIEW LETTERS week ending 28 MARCH 2014

Ultrashort Single-Wall Carbon Nanotubes Reveal Field-Emission Coulomb Blockade and Highest Electron-Source Brightness

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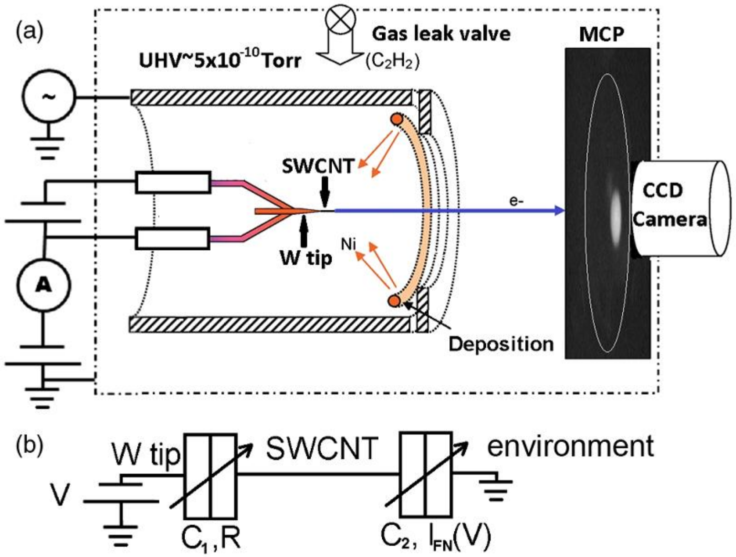
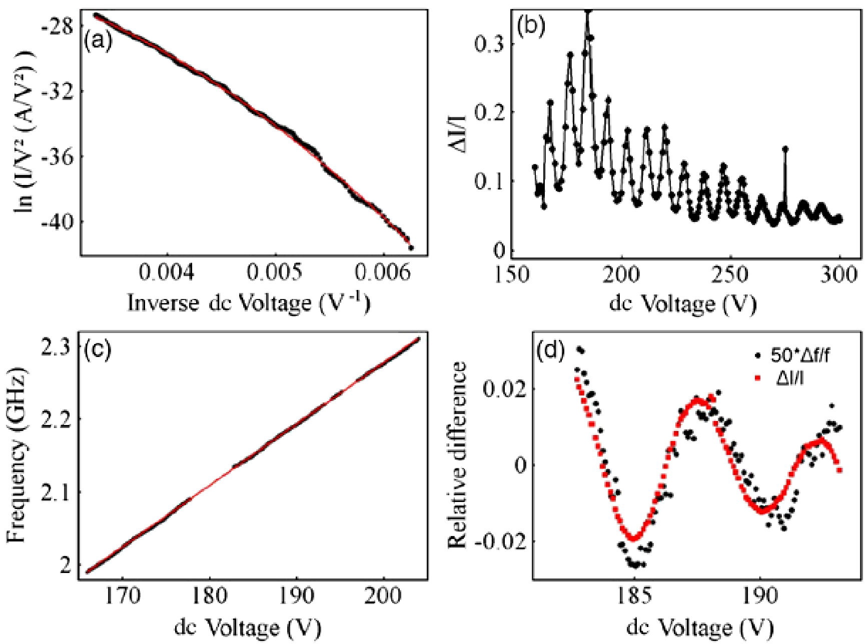
(Received 18 December 2013; published 26 March 2014)

Ultrashort Single-Wall Carbon Nanotubes Reveal Field-Emission Coulomb Blockade and Highest Electron-Source Brightness

- Coulomb blockade
  two tunnel junctions + island
- field emission + Coulomb blockade
  the most resistive junction is the vacuum barrier
- on-demand single electron source
- high brigthness is needed for experiments
- for a RT application: $E_e > 25$ meV





- periodicity of 8.5 V in the I(V) curve
- mechanical resonance frequency/capacitance → length
- current-induced shortening → period up to 80 V
- $C_1 \approx 100\ C_2$
- I up to 1.8 uA