Conducting polymers functionalized carbon nanotubes for applications in the rechargeable lithium batteries

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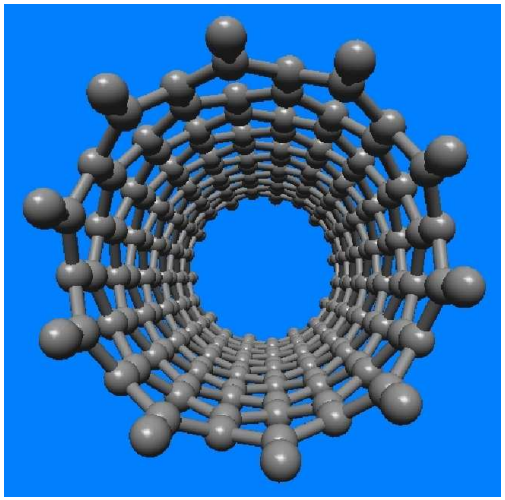
Different topics developed in NIMP

Optical properties
Chem.Phys.Lett. 406,222,2005

Chemical properties:
p doping, intercalation, functionalization
Carbon 40,2201, 2002

Electrochemical properties:
n doping, functionalization
Carbon 47, 1389,2009



Inorganic/ Inorganic composites
Semiconductors/carbon nanotubes
synthesis/characterization
J.Phys. Cond. Mat. 21,445801, 2009

Organic/inorganic composite
polymer/carbon nanotubes
synthesis /characterization
J. Mat. Chem. 19, 5690, 2009

Applications

Storage energy
Small 2,1075, 2006

Non-linear optics
Phys. Rev. B72, 245402, 2005

Functionalization of Carbon Nanotubes (CNs)

with conducting polymers (CPs) can be achieved by:
- mixing of the two constituents, i.e. CPs and CNs;
- chemical polymerization of monomere in the presence of CNs;
- electropolymerization of monomere on the CNs thin film.

Covalent Functionalization of the side walls

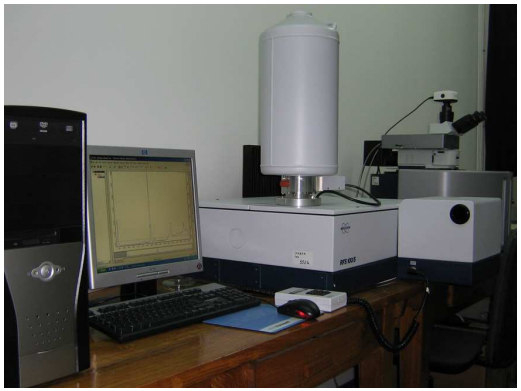
→ New covalent bonds between the two constituents
(PEDOT/SWNTs; Diamond&Related Mater 14, 867, 2005)
(PVK/SWNTs; Polymer 48, 5279, 2007)

Non-Covalent Functionalization with polymers

→ Wrapping of polymer around SWNTs
(PPV/SWNTs; J.Chem.Phys. 125, 014703, 2006)

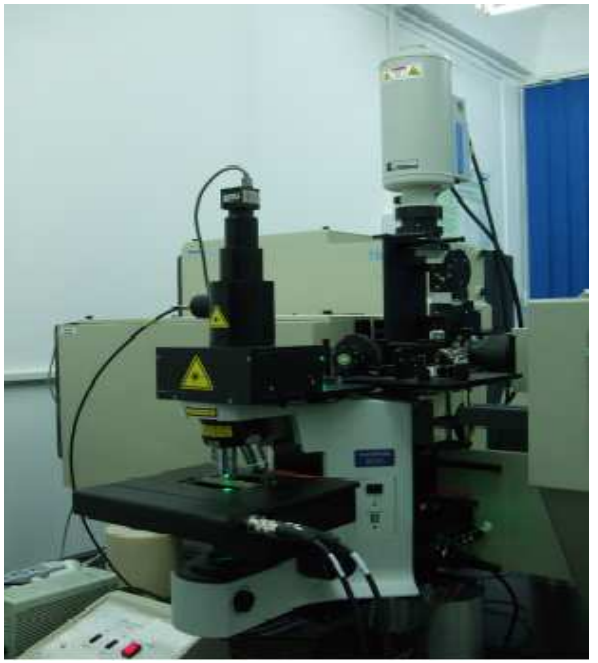
CPs doped with CNs

→ Charge transfer between CPs and CNs
(PANI/SWNTs; Chem. Mat. 15, 4149, 2003)



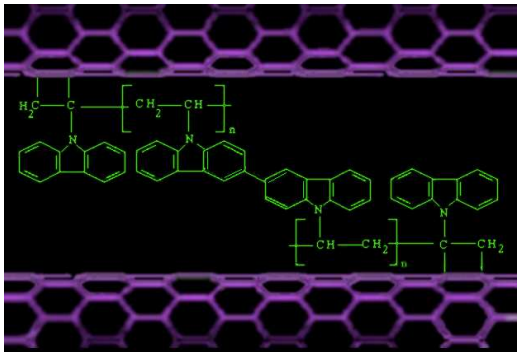
FTRaman RFS 100/S Bruker
1064 nm

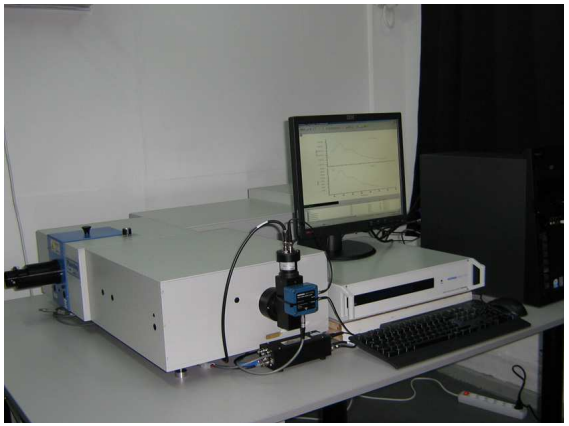
FTIR Vertex 70 Bruker



Raman T64000, Horiba Jobin Yvon, domeniul VIS

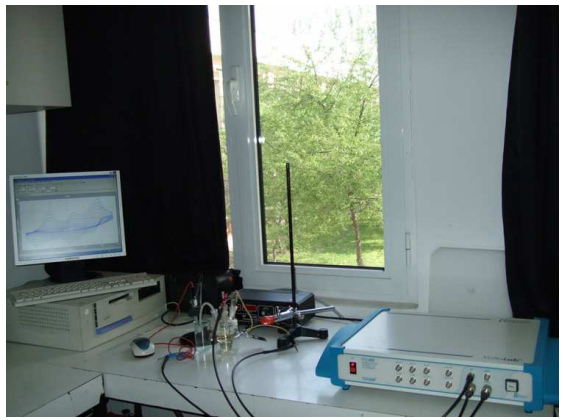
Equipments used to characterization of carbon nanotubes and their composites





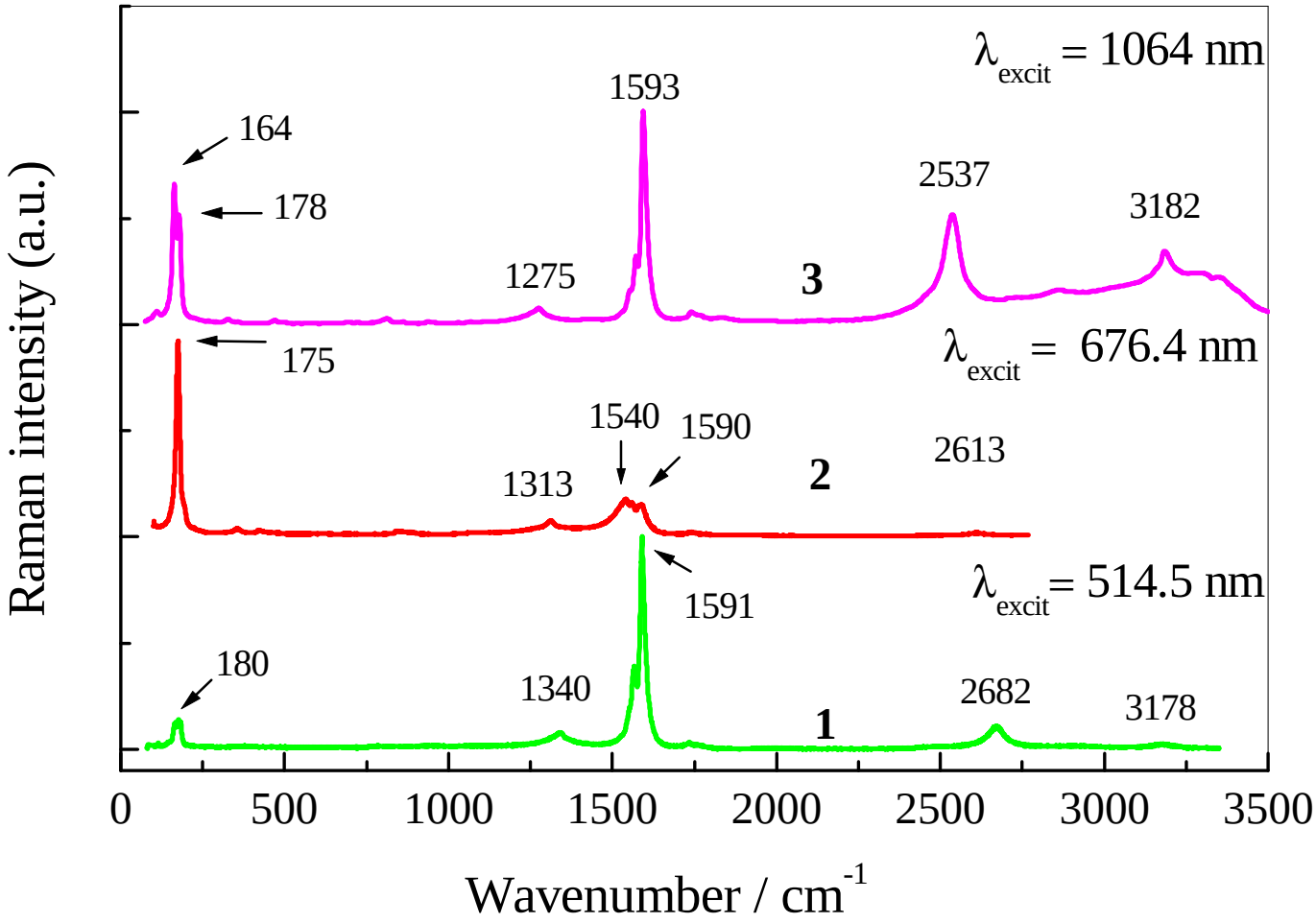
Fluorolog 3.2.2.1, Horiba Jobin Yvon

UV-VIS-NIR, Lambda 90, Perkin Elmer



Potentiostat Voltalab 80, Radiometer Analytical

Raman spectra of carbon nanotubes



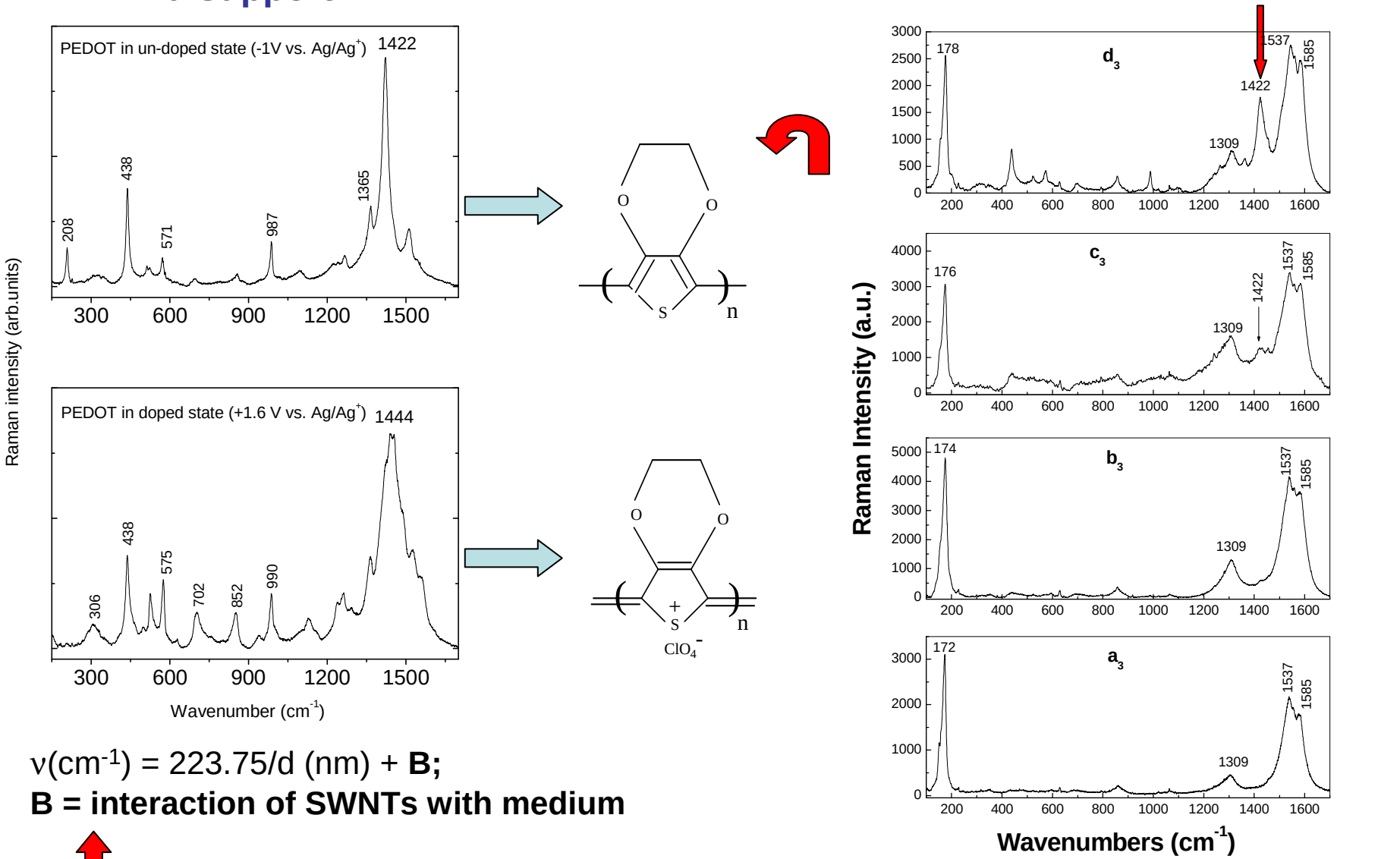
Physical Review B 65, 235401, 2002

Poly (3,4-ethylenedioxythiophene) (PEDOT)

Au support

$\lambda_{exc.}$ = 676 nm

SWNTs/Au support; -1V vs. Ag/Ag$^+$



$\nu(cm^{-1}) = 223.75/d\ (nm) + \mathbf{B}$;

B = interaction of SWNTs with medium

PEDOT covalently functionalized SWNTs

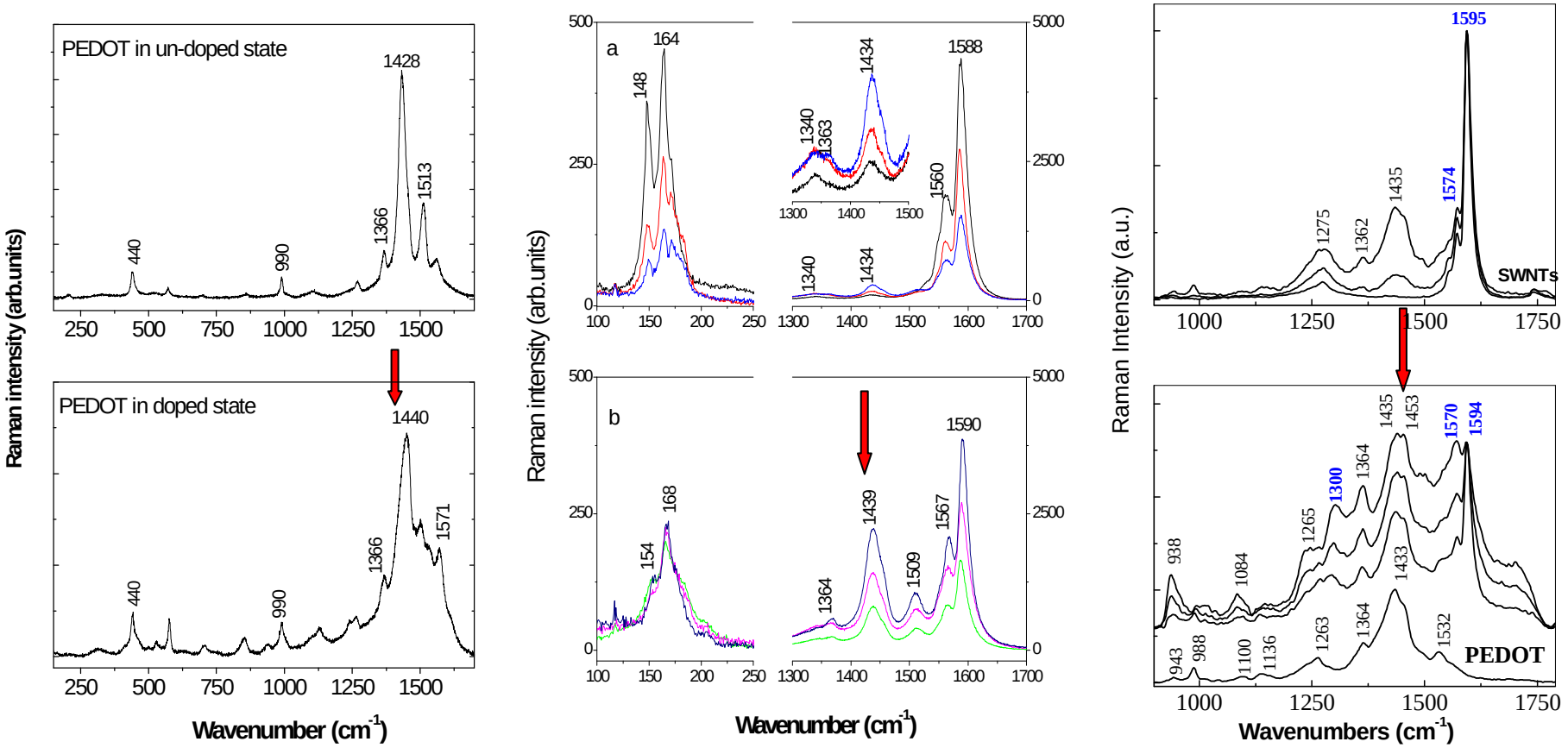
Poly (3,4-ethylenedioxythiophene) (PEDOT)

$\lambda_{exc.}$ = 514 nm

Au support

$\lambda_{exc.}$ = 1064 nm

SWNTs/Au support; -1V vs. Ag/Ag$^+$



PEDOT doped with SWNTs$^{-\cdot}$, PEDOT covalently functionalized SWNTs

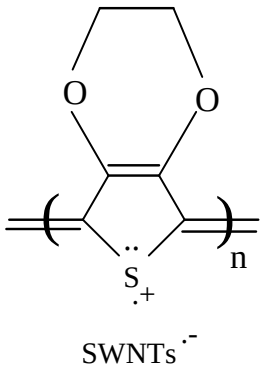
J. Raman Spectroscopy in press 2010

Diamond and Related Materials 14, 867, 2005

Poly (3,4-ethylenedioxythiophene) (PEDOT)

Electrochemical polymerization of a monomer on the SWNTs film

SWNTs



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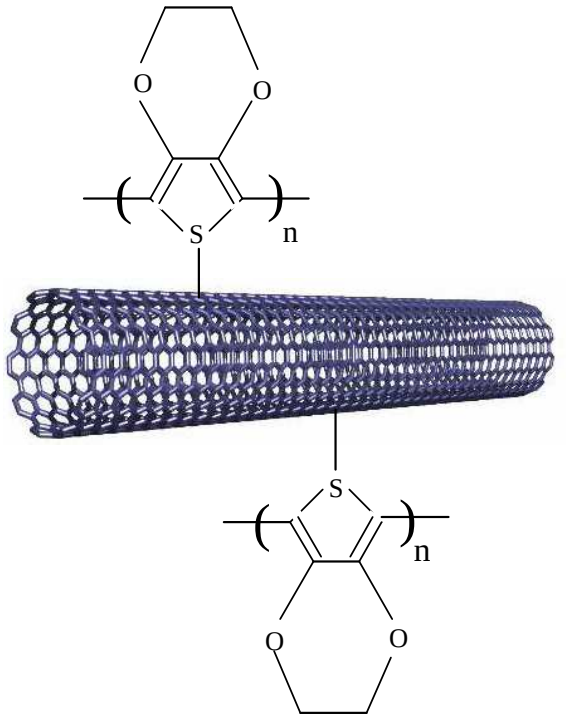


PEDOT doped with $SWNTs^{-\cdot}$

PEDOT covalently functionalized SWNTs

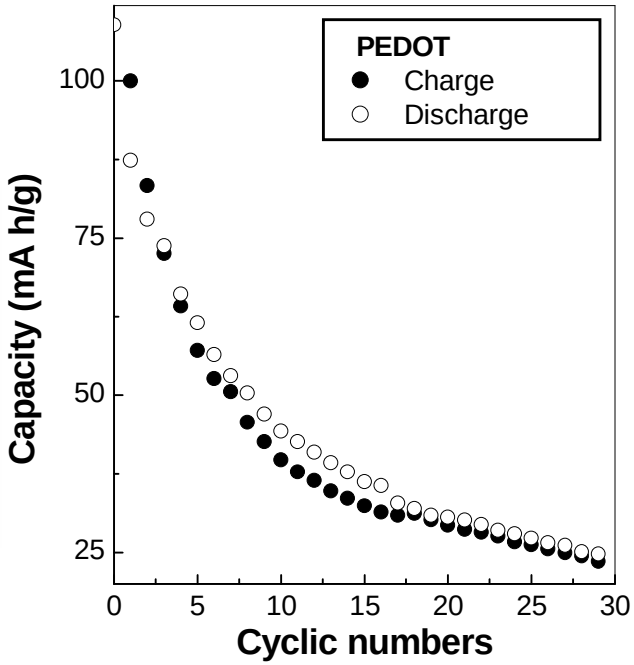
Current Organic Chemistry, 2010, in press

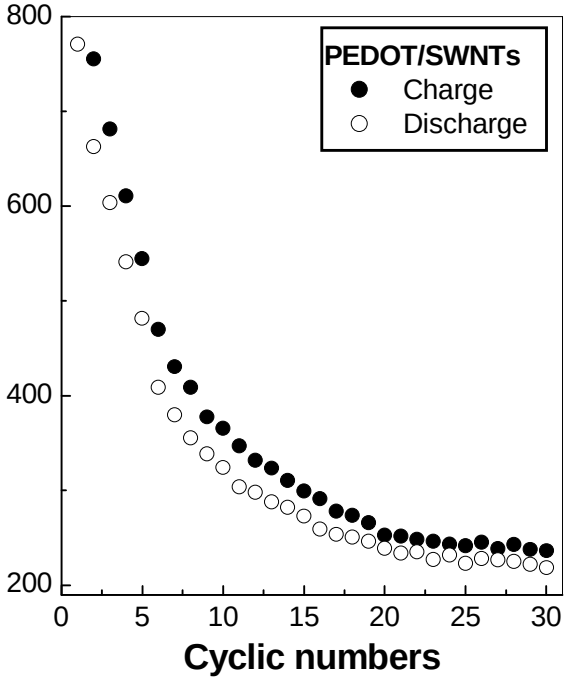
PEDOT/SWNTs composite as active material in positive electrode of rechargeable lithium cell

Li-Battery development

Mobile electronics:
cellular phone, Laptop, etc.

Requests:
-**Specific energy <100 Wh Kg^{-1}**
-**Low cost**
-**2-3 years/200 cycles lifetime**





1M $LiPF_6$ in EC:DMC (50:50)
10 mA g^{-1}; (2; 4.4) V

Li/$LiFP_6$/PEDOT-SWNTs composite; Discharge capacity = 218 mA h g^{-1};
Li/$LiFP_6$/PEDOT Discharge capacity = 25 mA h g^{-1};

Journal of Nanoscience and Nanotechnology 9, 6204, 2009

Conclusions:

Raman spectroscopy is a valuable tool to evaluate the functionalization process of carbon nanotubes with conducting polymers

⇔ Electrochemical polymerization of EDOT in the presence of SWNTs results in:

⇔ 1) PEDOT covalently functionalized SWNTs

⇔ 2) PEDOT doped with SWNTs

⇔ The values of specific discharge capacity of the PEDOT/SWNTs composite and PEDOT of 218 mA h g^{-1} and 25 mA h g^{-1} are reported.

THANK YOU FOR YOUR ATTENTION