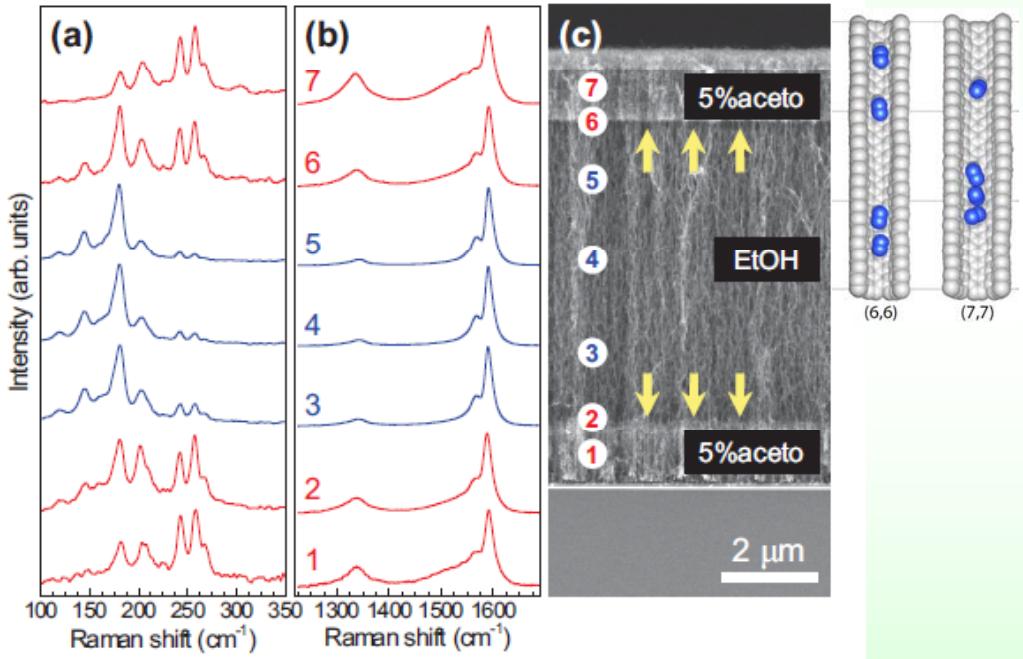
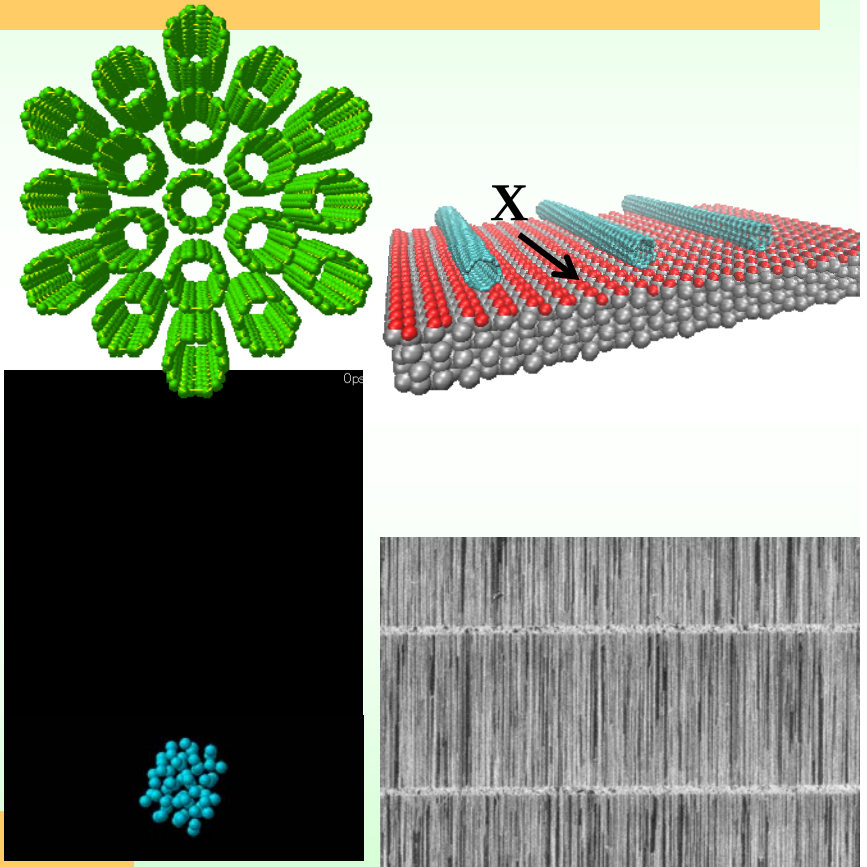
Nitrogen Incorporated Vertically Aligned SWNTs





Shigeo Maruyama
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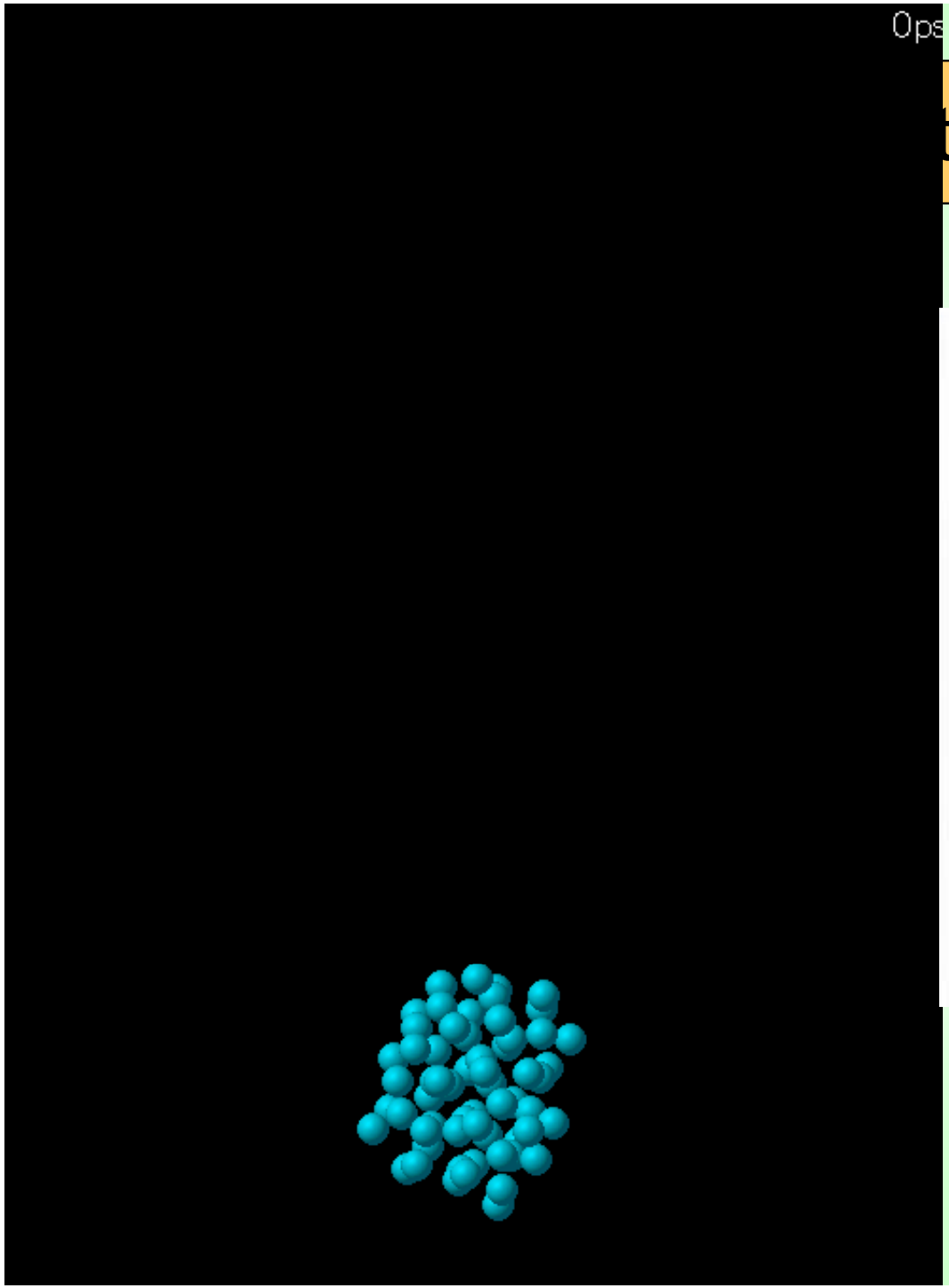
Carbon Nanotube and Nano-Therm. Lab.

Feb. 15, 2012

Professor: 1(0); Associate Professor: 1(0); Lecturer: 1(1); Assistant Professor: 1(0);
Technician: 1(0); Secretary: 2(0),
PD: 4(3); D3: 2(1); D2: 4(3); D1: 5(4); M2: 8(1); M1: 5(1); B4: 7(0); Total: 43(14)
[China: 5, Korea: 3, India: 2, Thailand:1, US: 1, UK: 1, Austria:1]



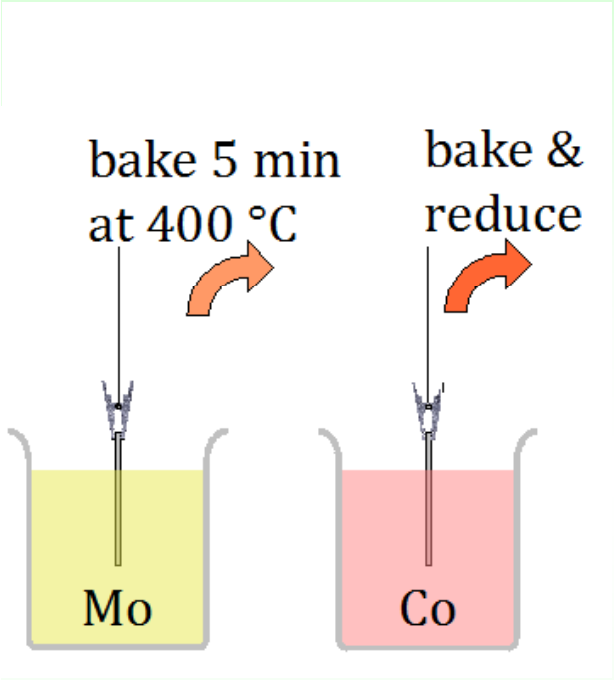
th Process with Co

80 ns 126 ns

Octopus Growth

(m=60, n=6, 1600 K)

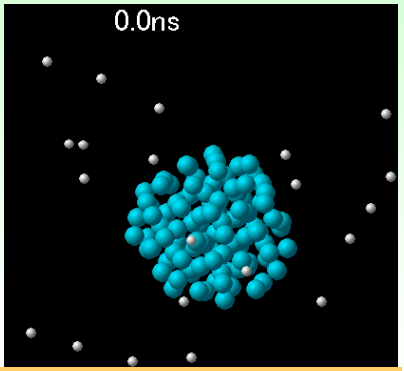
ACCVD Directly on Surfaces (Dip-Coat)



10 min soak
& 4 cm/min

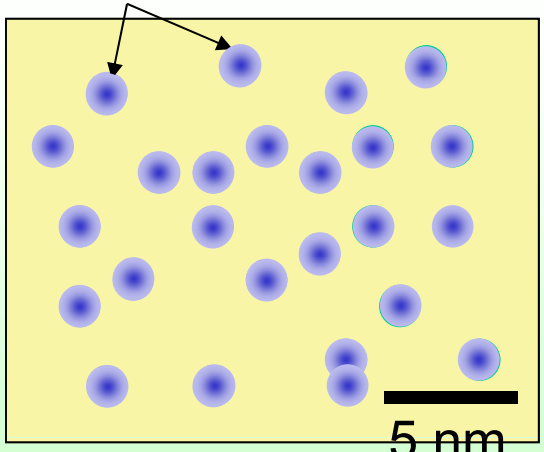
Mo/Co 0.01wt %
Ethanol Solution
$(CH_3COO)_2Mo$
$(CH_3COO)_2Co\text{-}4H_2O$

Heat up to 800 °C
in Ar/H_2 (3 % H_2)

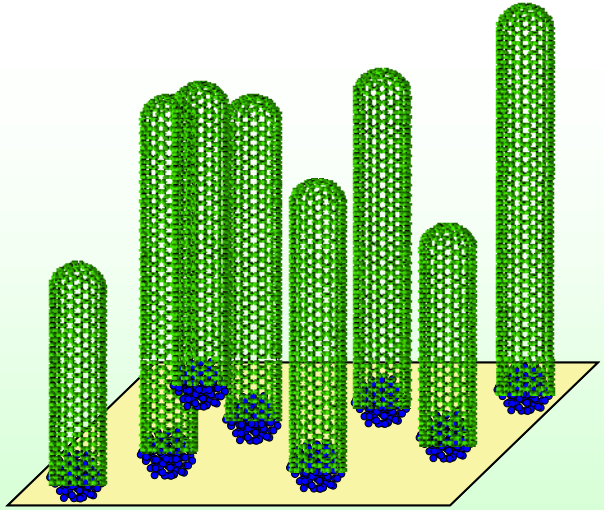


Y. Shibuta et al.,
CPL 382(2003)381.

1.5 nm Metal
Particles



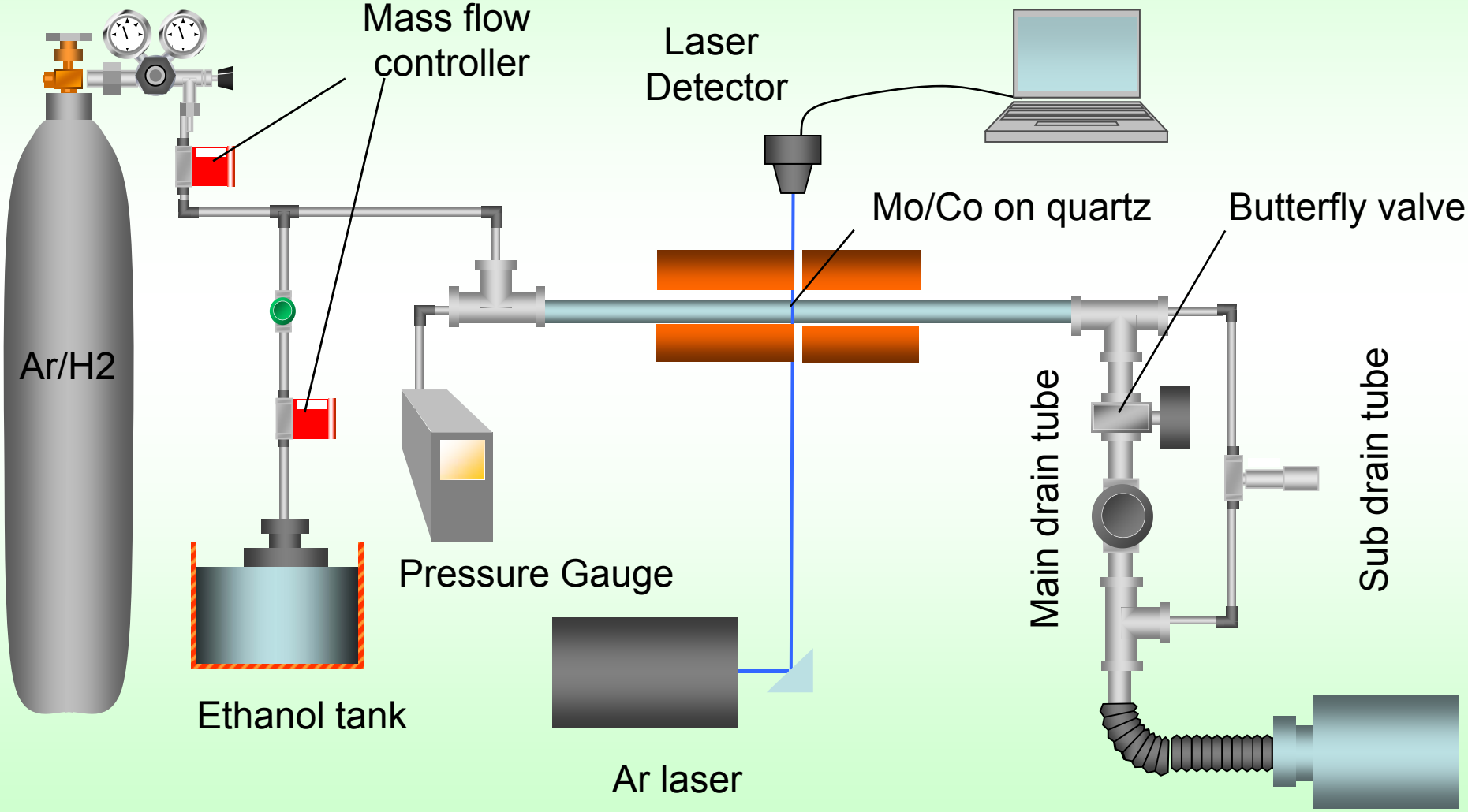
Si or Quartz Substrate



bundle.pv

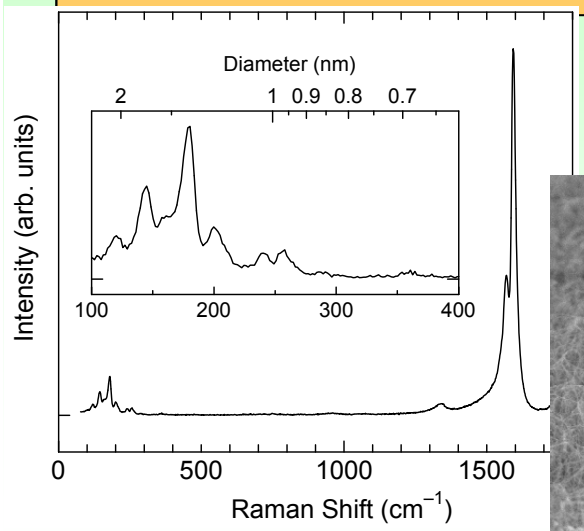
Y. Murakami et al.,
Chem. Phys. Lett., 377(2003)49.

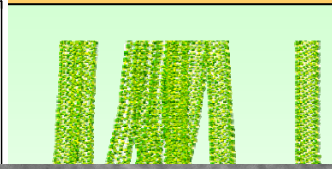
ACCVD Apparatus

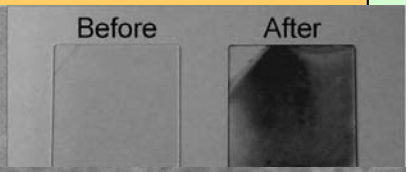


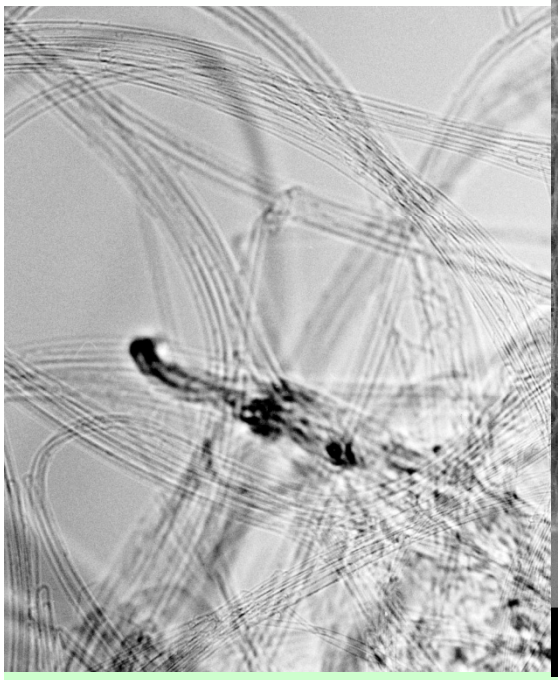
S. Maruyama et al., CPL 403 (2005) 320.

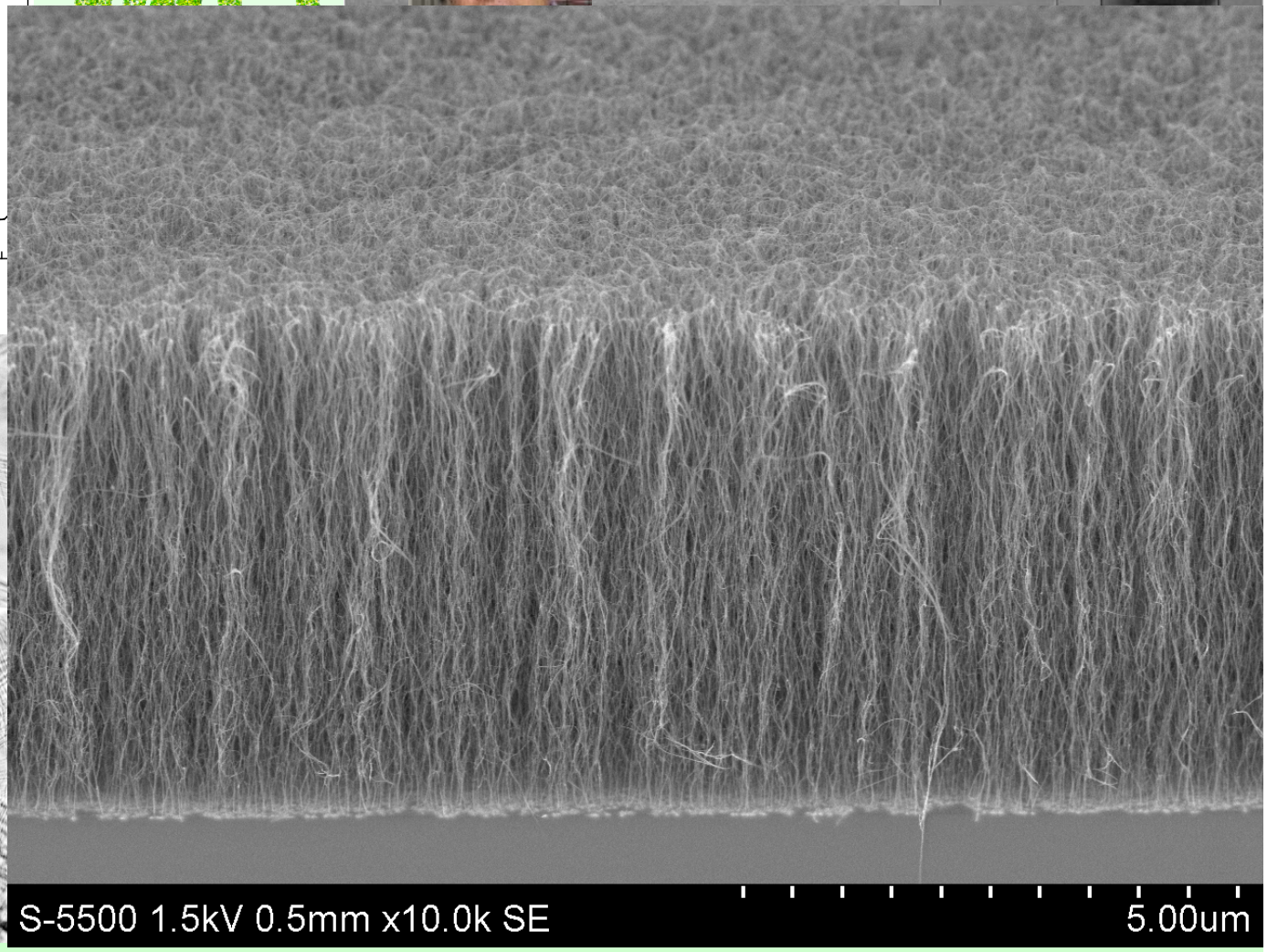
Vertically Aligned SWNTs on Quartz Substrate





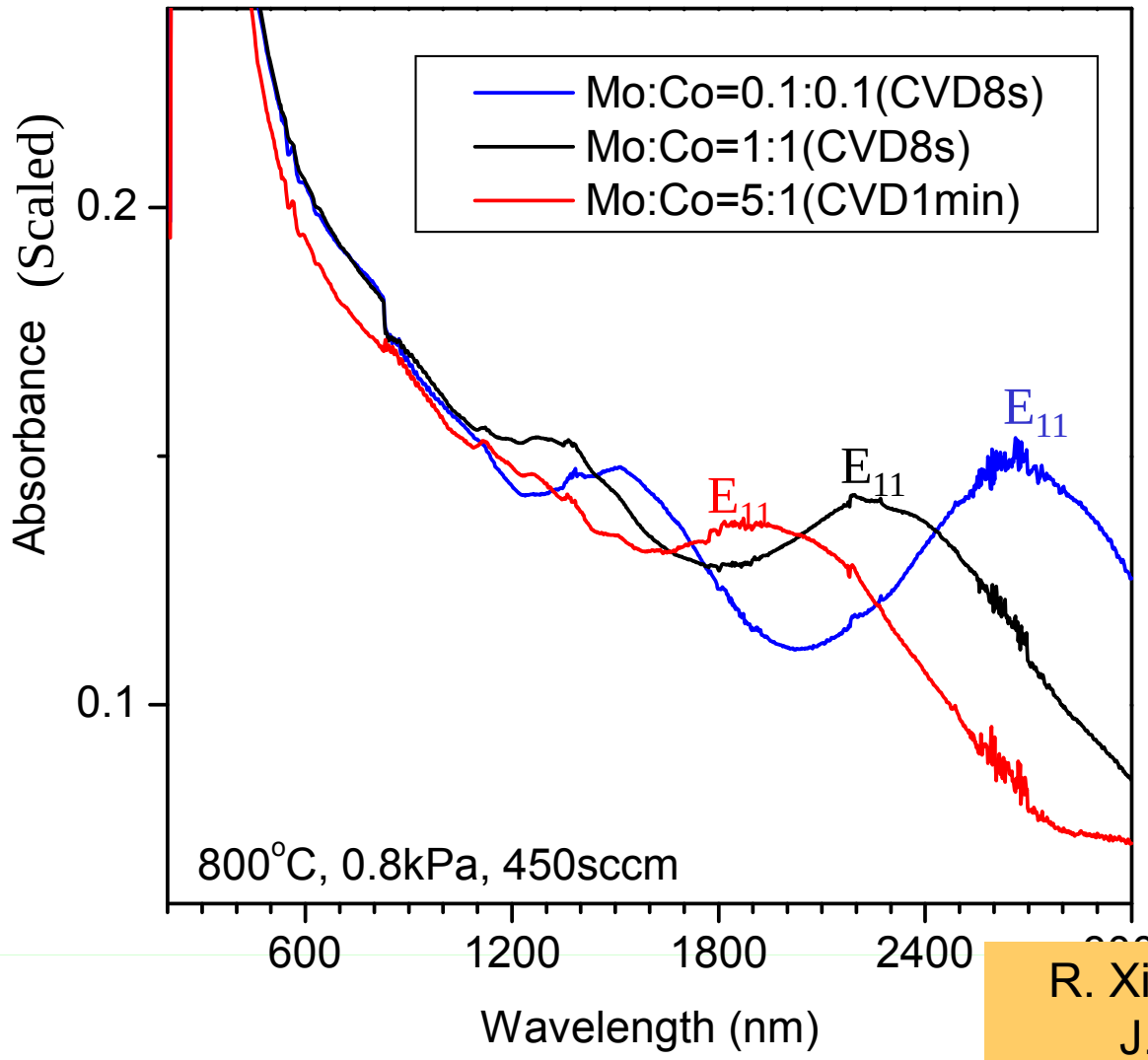


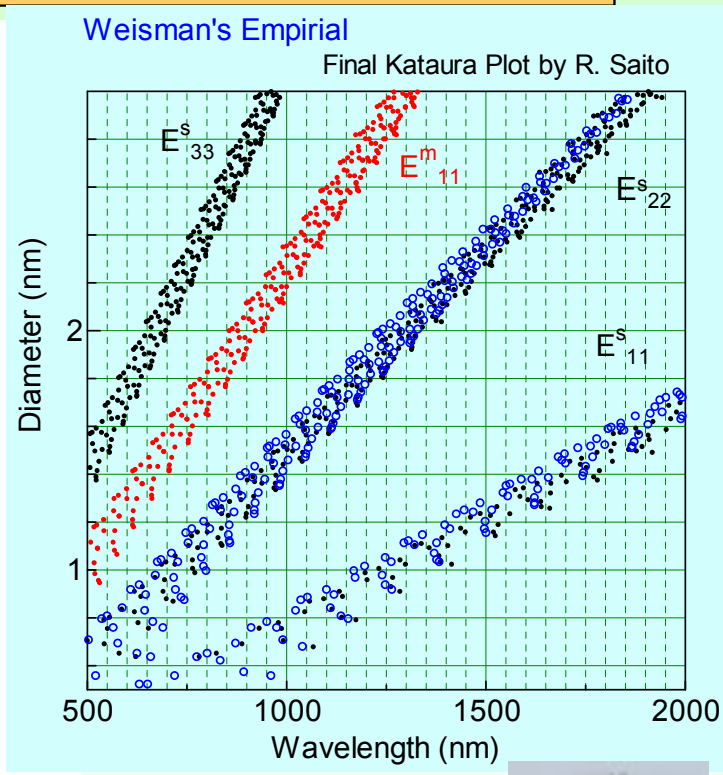




Y. Murakami, S. Chiashi, Y. Miyauchi, M. Hu, M. Ogura, T. Okubo, S. Maruyama, Chem. Phys. Lett. 385 (2004) 298

Control of Diameter

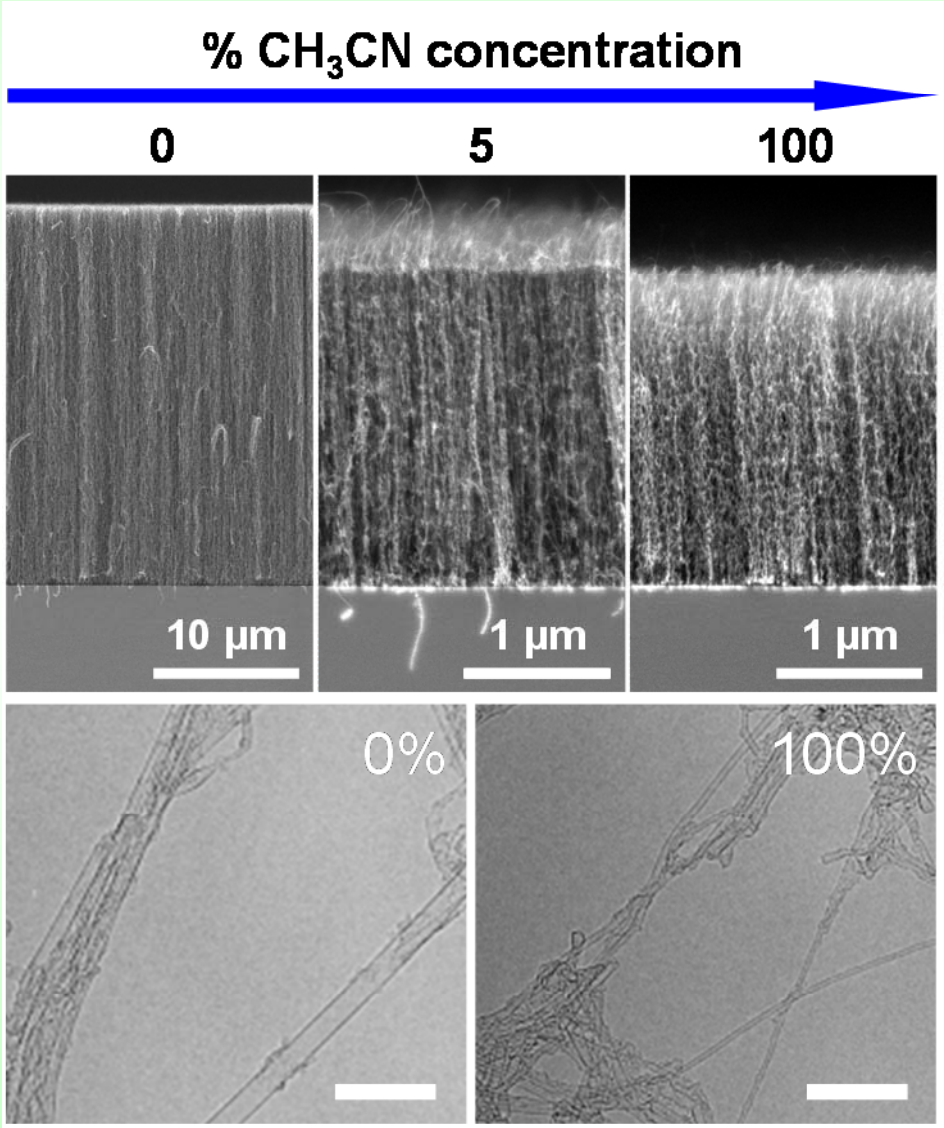


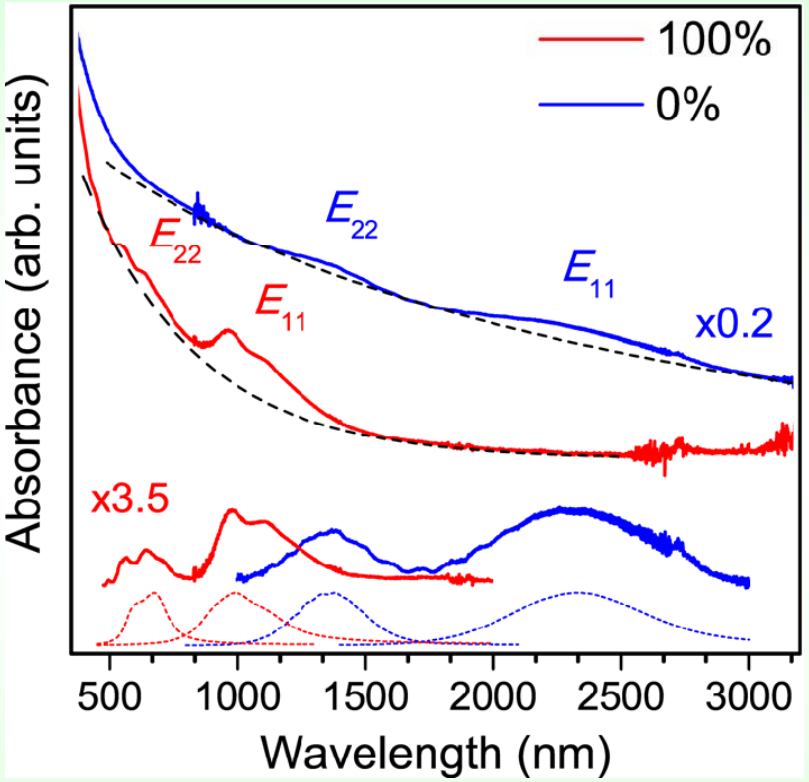


Rong Xiang

R. Xiang, E. Einarsson, Y. Murakami, J. Shiomi, S. Chiashi, Z. Tang, S. Maruyama, ACS Nano, 6 (2012) 7472.

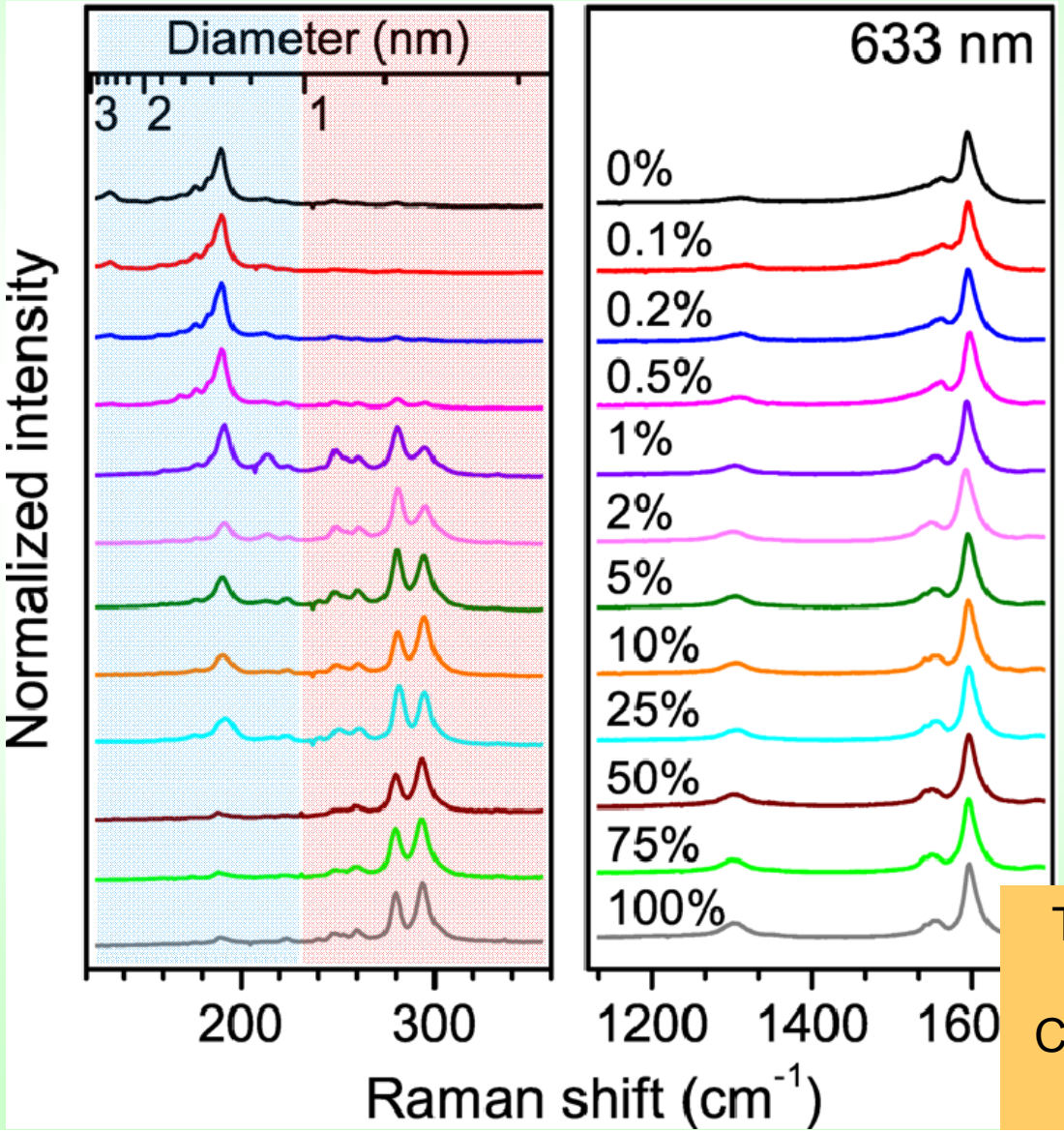
Growth of VA-SWNTs from Ethanol and Acetonitrile





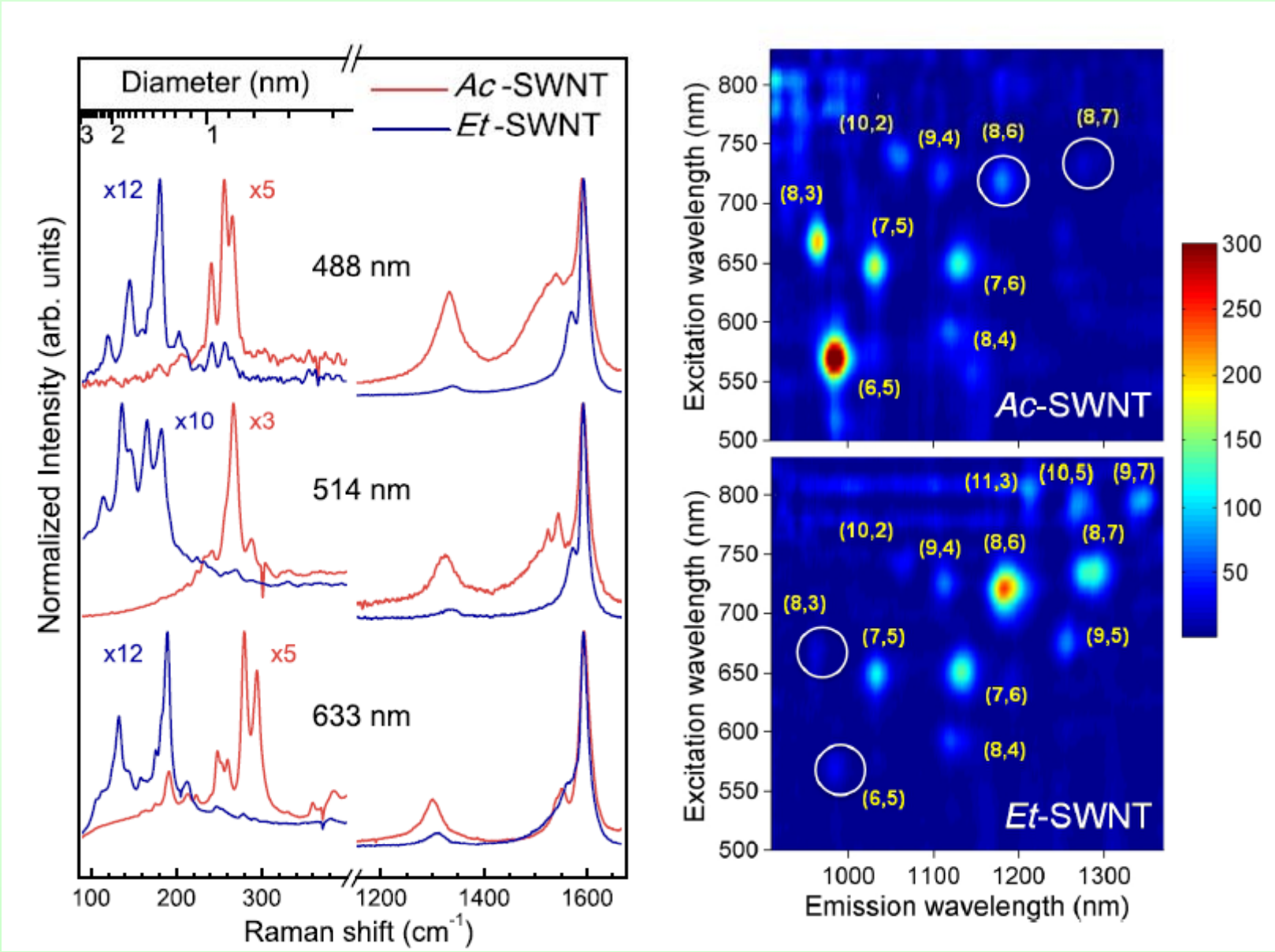
T. Thurakitseree, C. Kramberger, P. Zhao, S. Aikawa, S. Harish, S. Chiashi, E. Einarsson, S. Maruyama, Carbon, 50 (2012) 2635.

Raman of VA-SWNTs from Ethanol and Acetonitrile

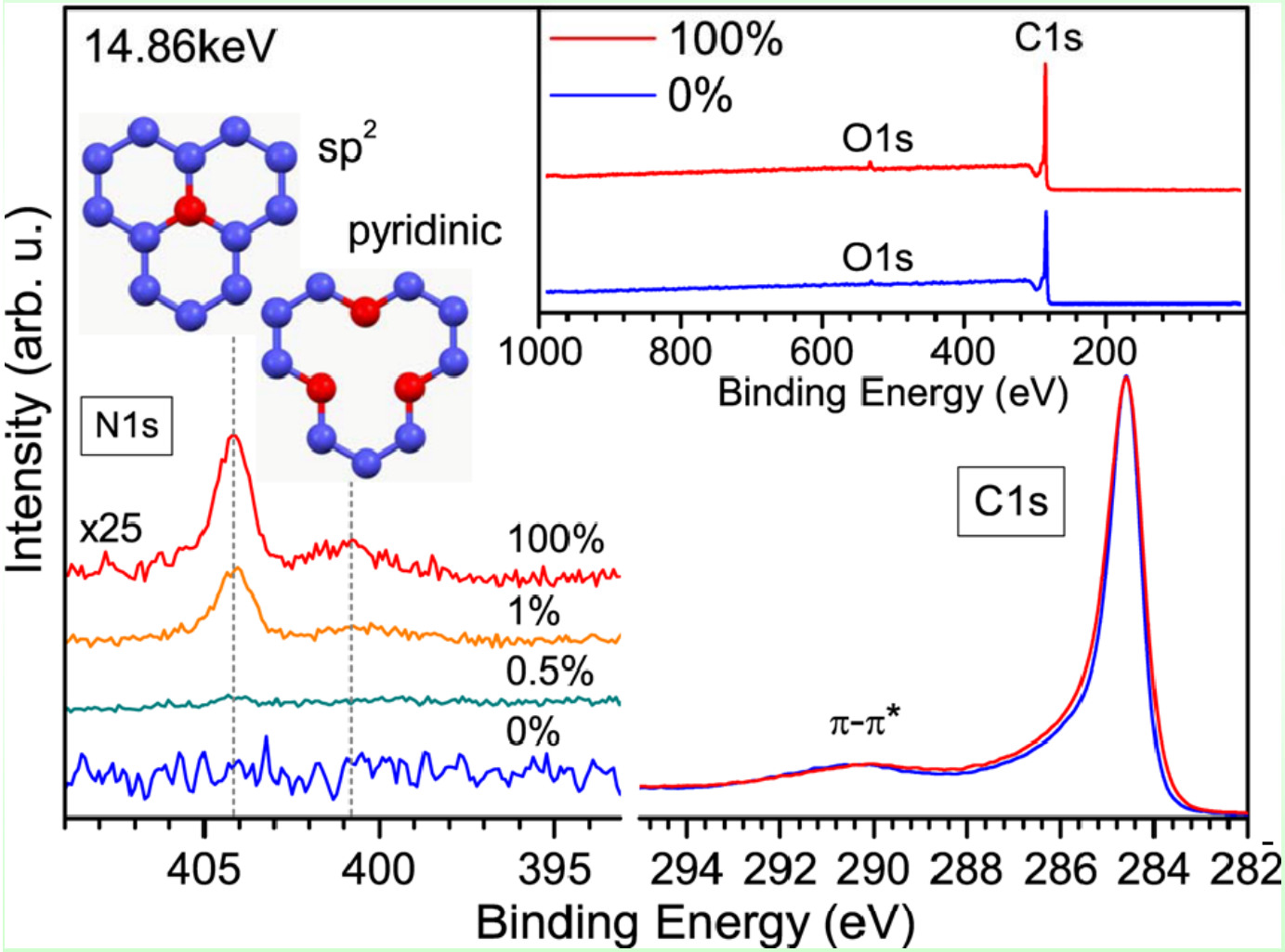


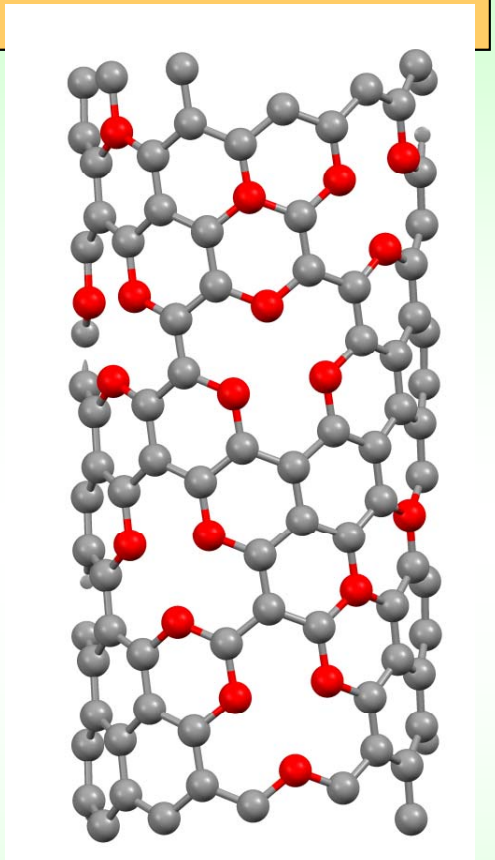
T. Thurakitseree, C. Kramberger, P. Zhao, S. Aikawa, S. Harish, S. Chiashi, E. Einarsson, S. Maruyama, Carbon, 50 (2012) 2635.

Chirality Distribution



XPS Proof of Doping





With pure acetontirile

Graphitic sp^2 N ≈ 1 at.% ***

- Pyridinic N ≈ 0.2 at.%

T. Thurakitseree, C. Kramberger, P. Zhao, S. Aikawa, S. Harish, S. Chiashi, E. Einarsson, S. Maruyama, Carbon, 50 (2012) 2635.

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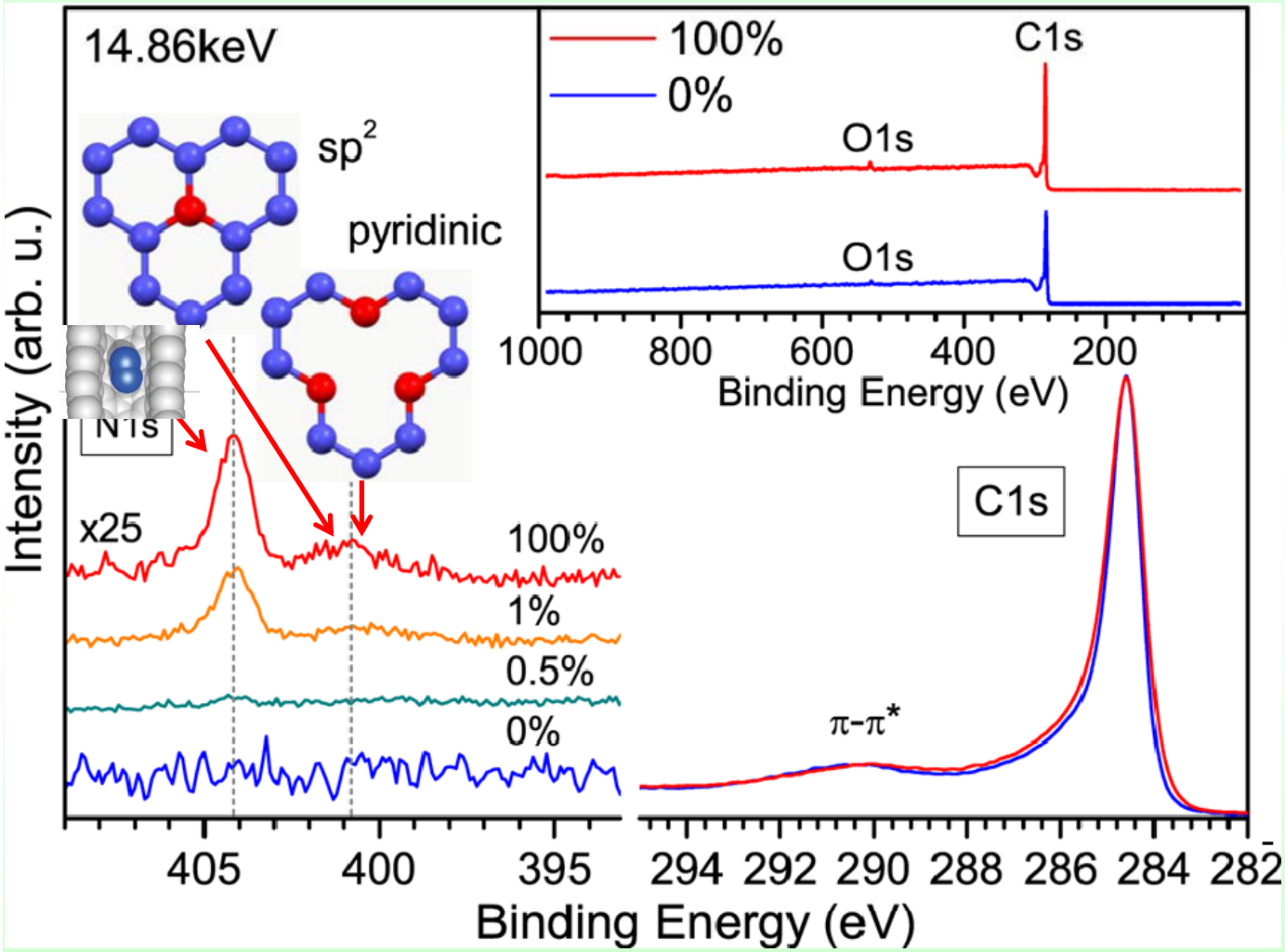

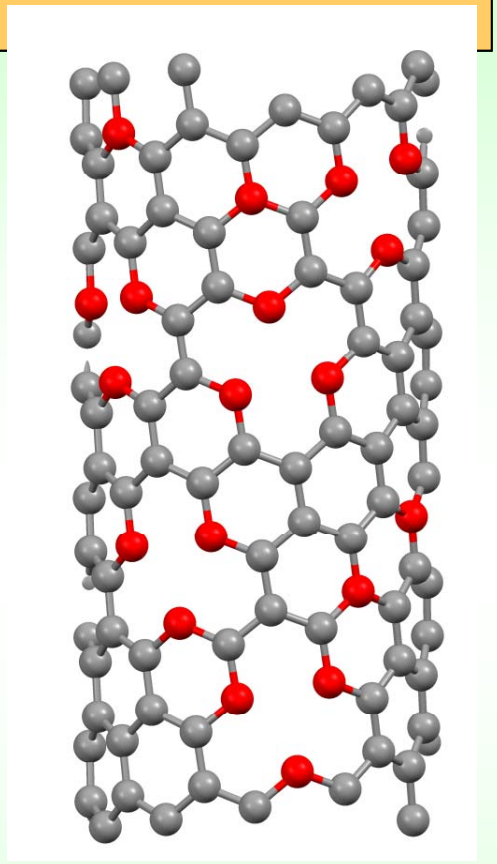

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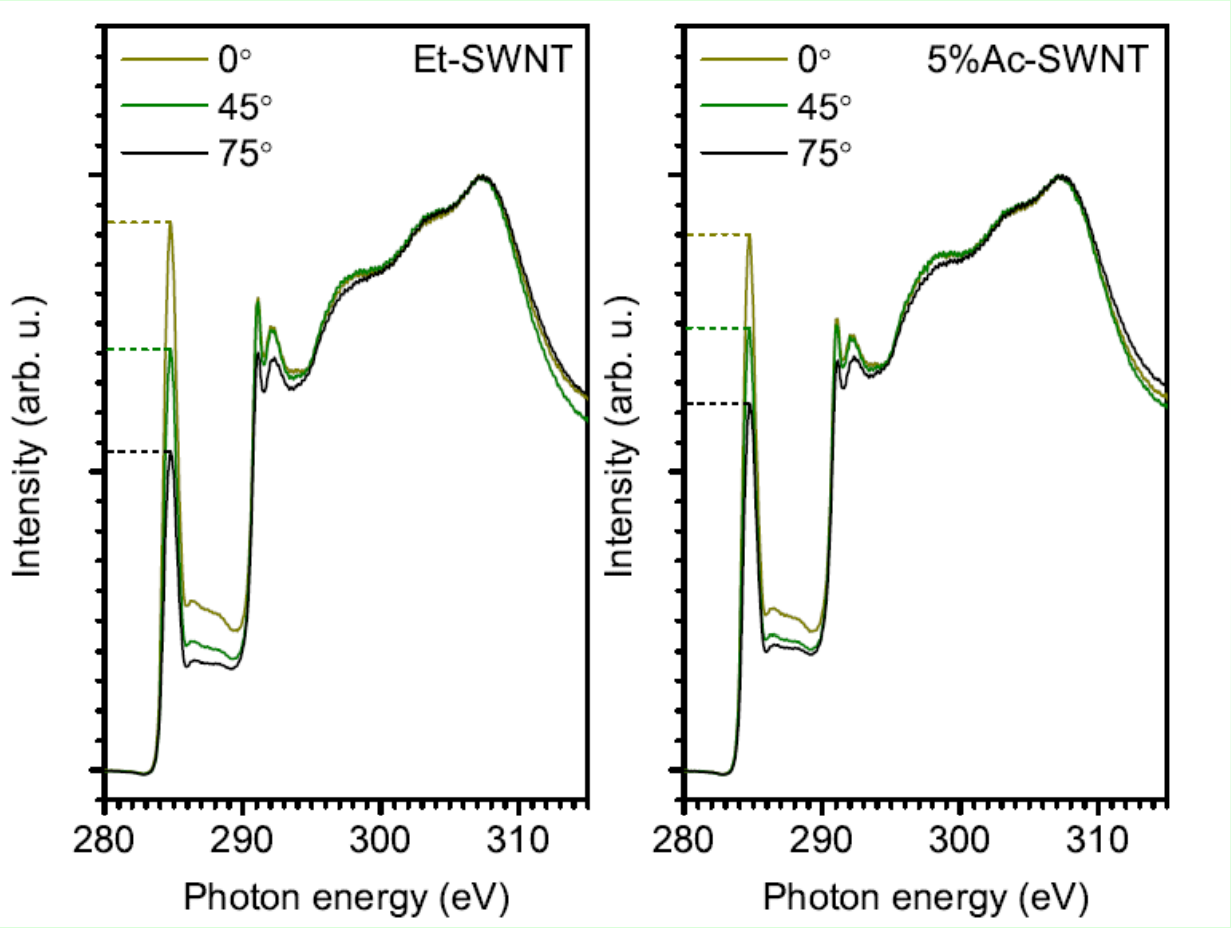
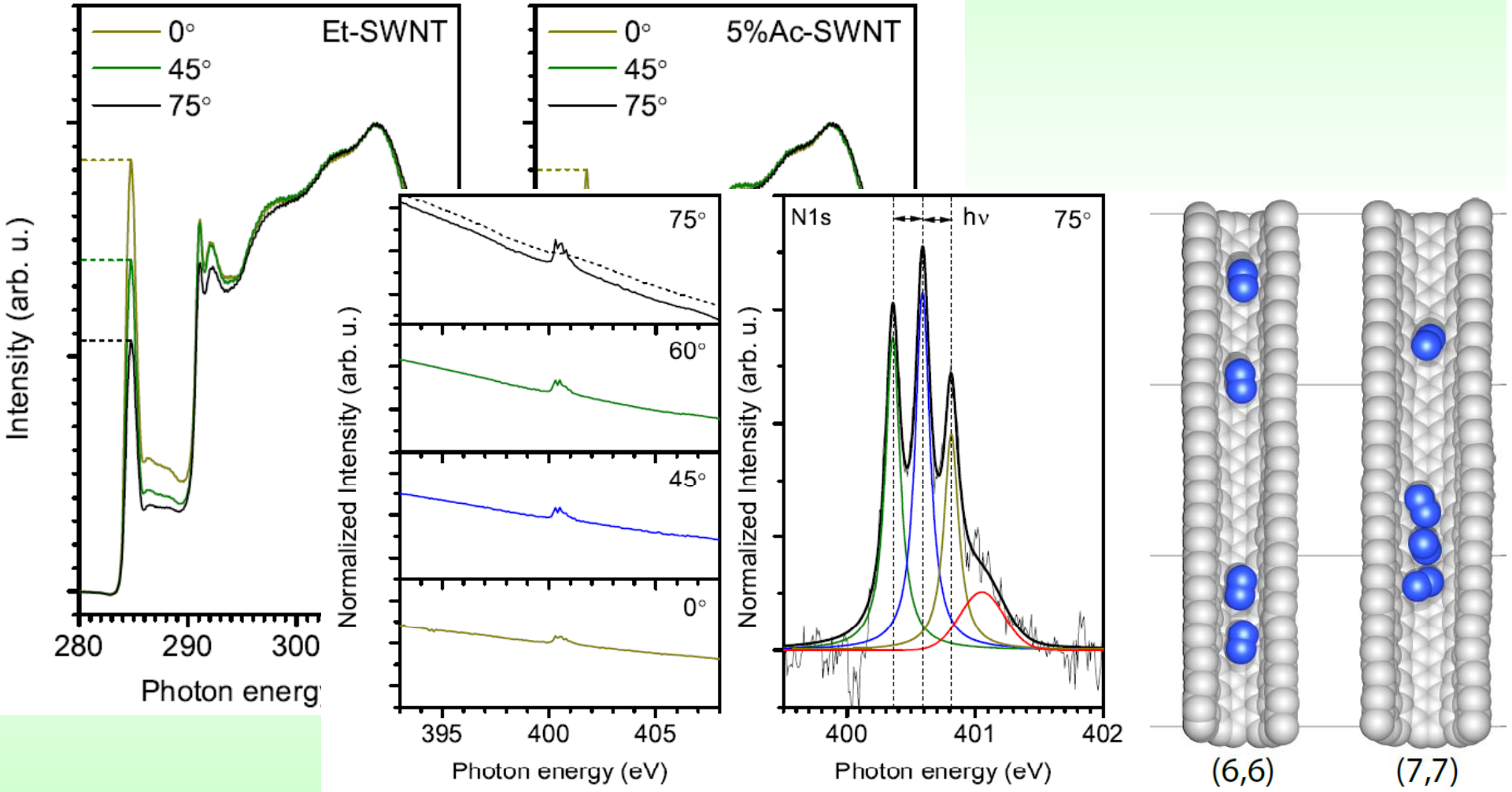
NEXAFS shows Aligned N2 molecules



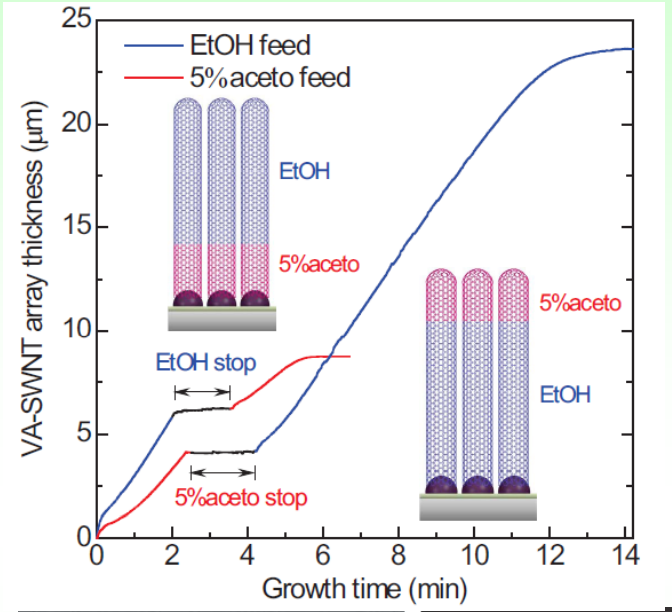
C. Kramberger, T. Thurakitseree, H. Koh, Y. Izumi, T. Kinoshita, E. Einarsson, S. Maruyama, submitted (2012).

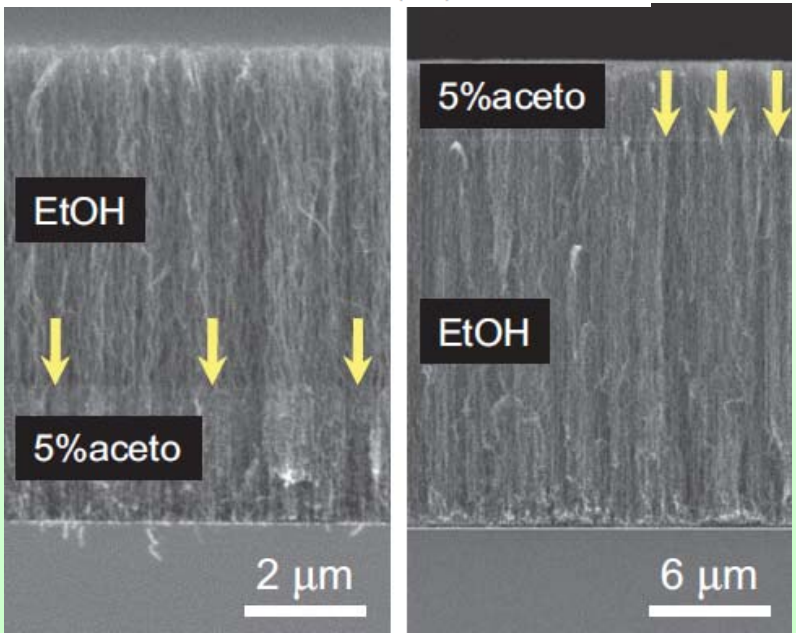
NEXAFS shows Aligned N2 molecules

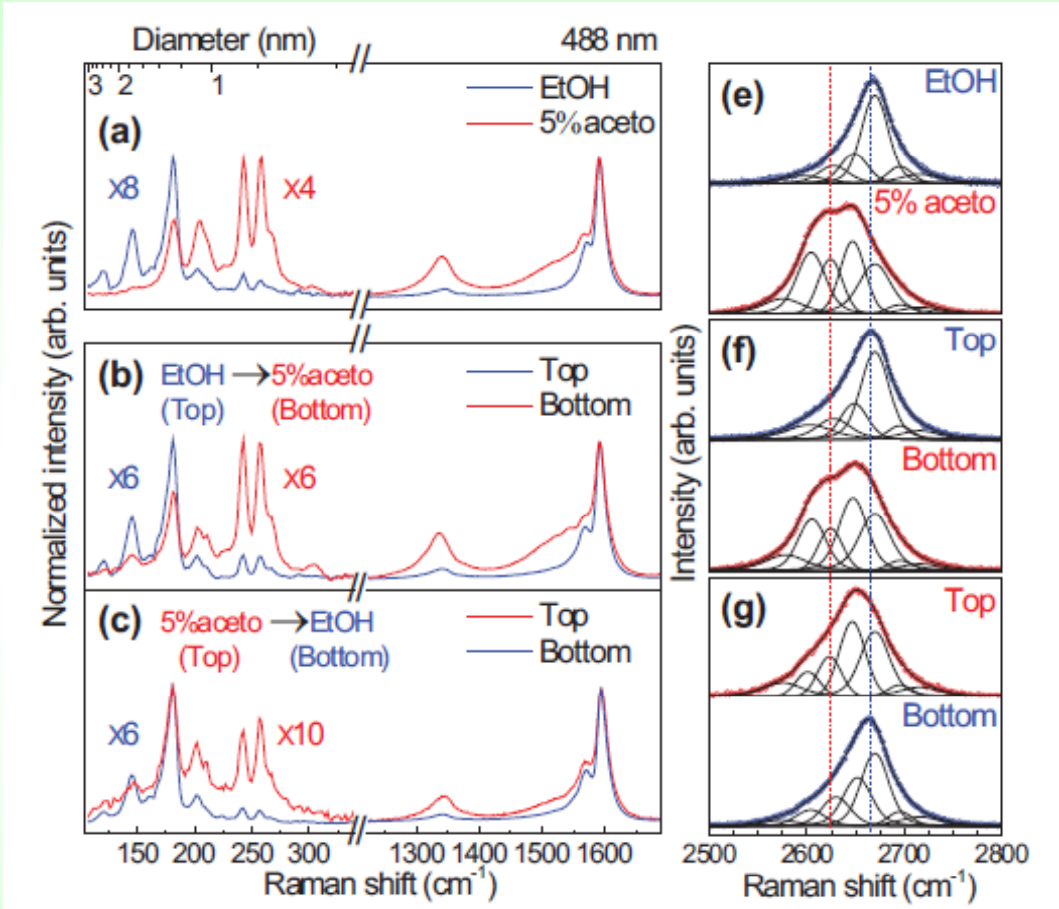


C. Kramberger, T. Thurakitseree, H. Koh, Y. Izumi, T. Kinoshita, E. Einarsson, S. Maruyama, submitted (2012).

Multi-Step Growth

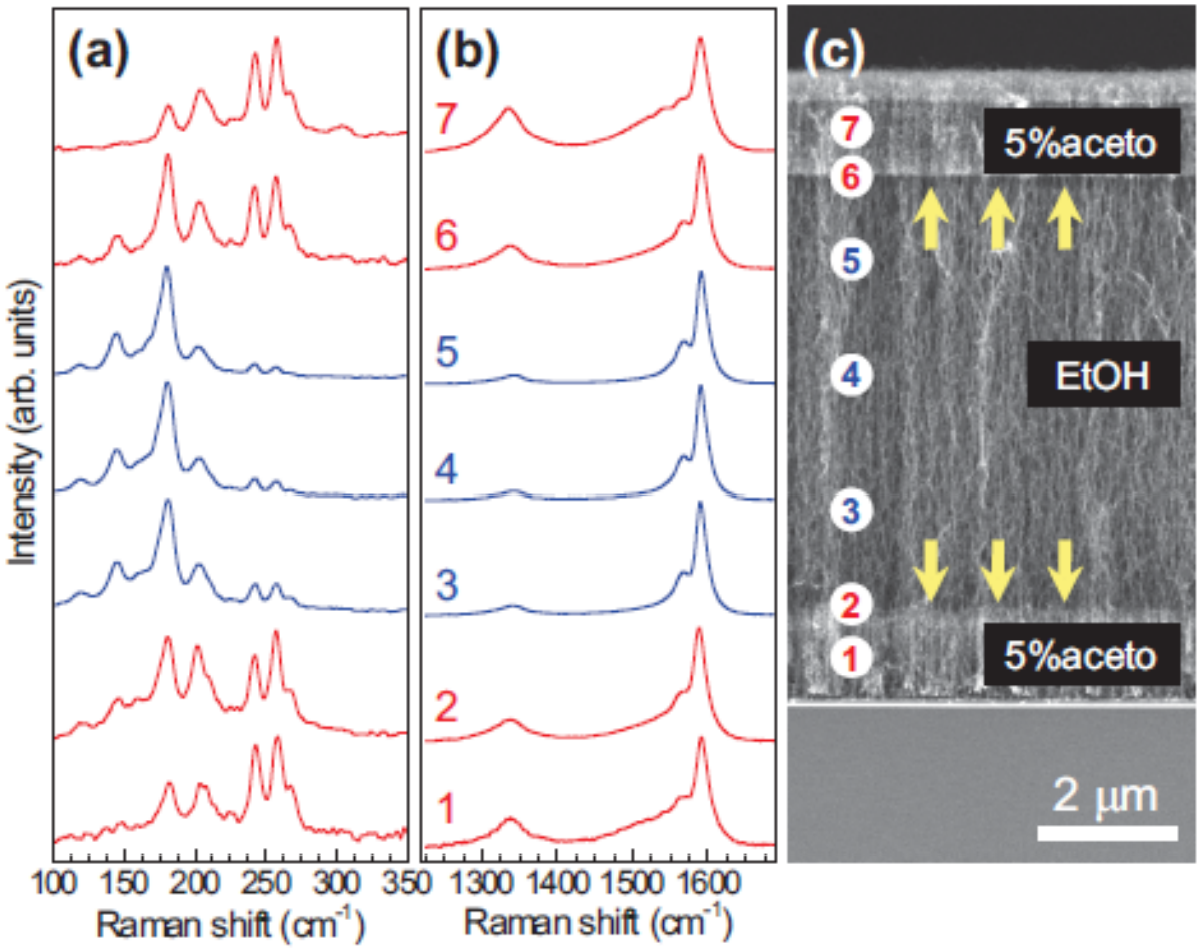


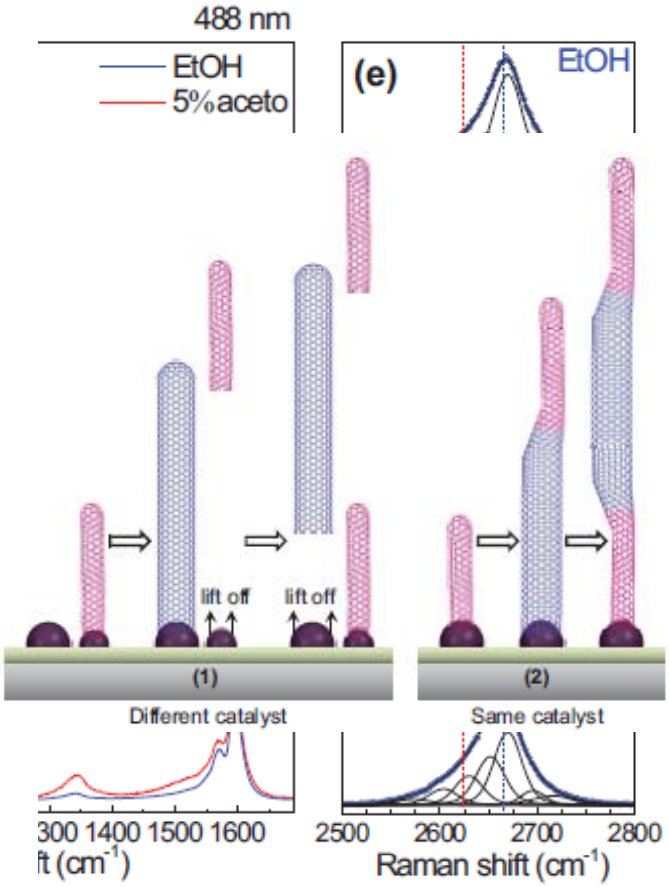


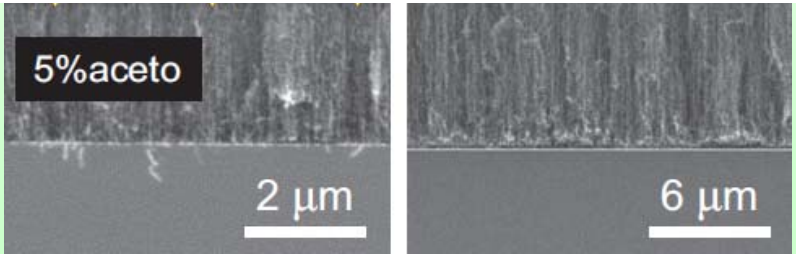


T. Thurakitseree et al., to be submitted (2012).

Multi-Step Growth

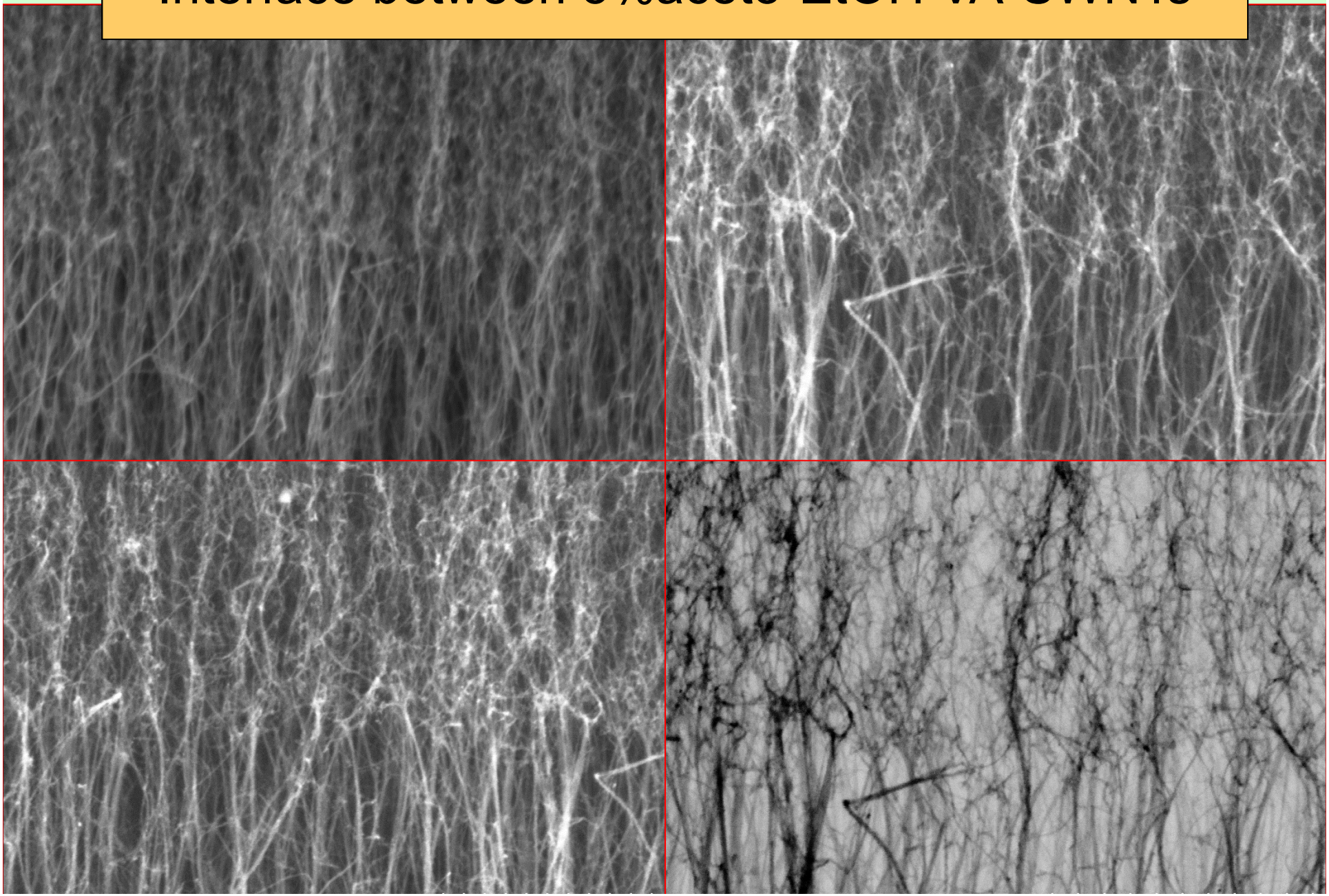




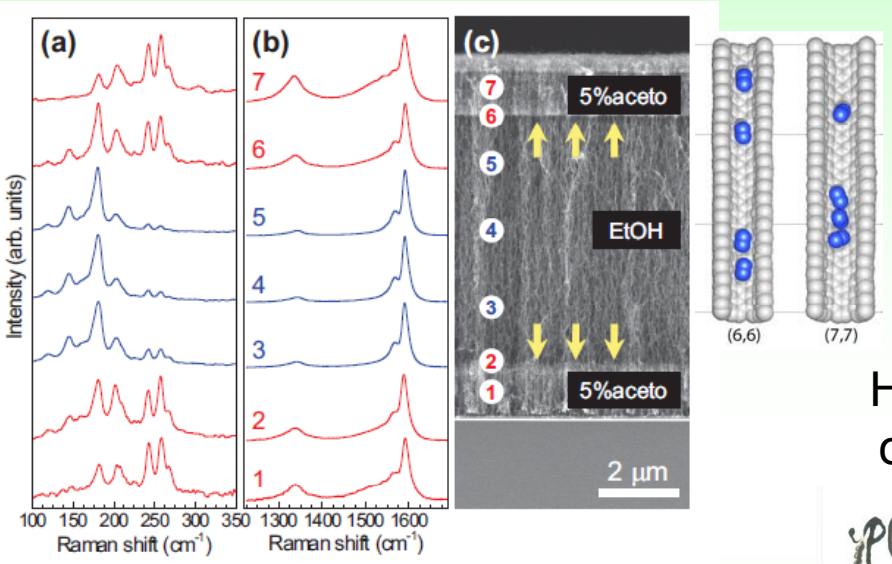


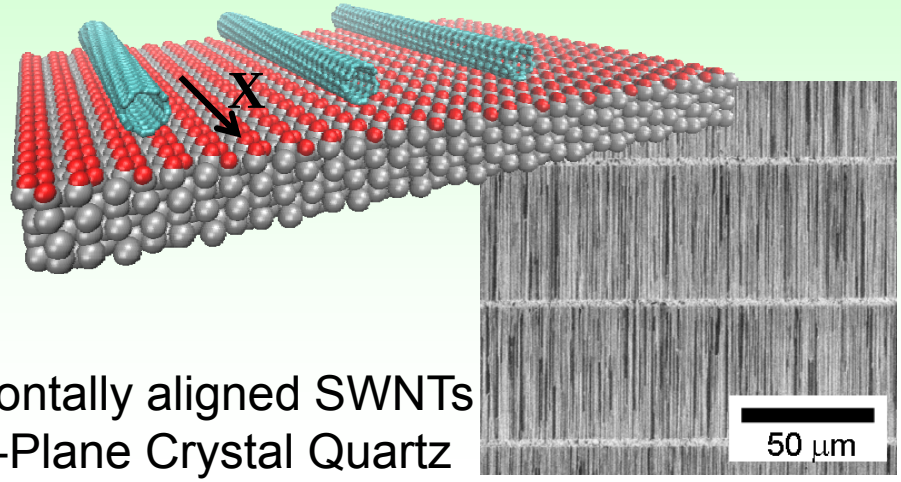
T. Thurakitseree et al., to be submitted (2012).

Interface between 5%aceto-EtOH VA-SWNTs



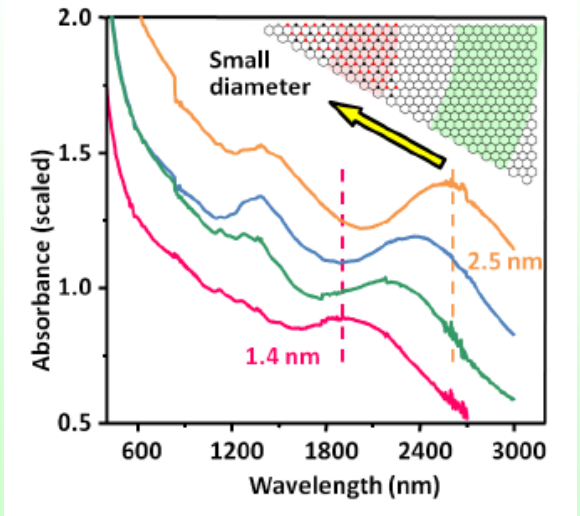
Summary





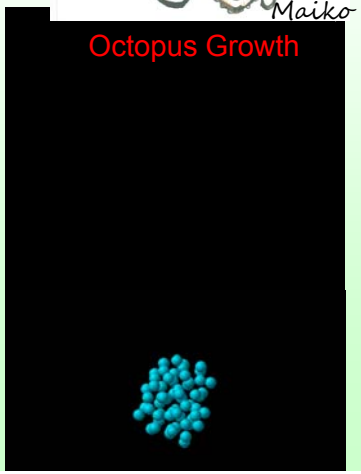
Horizontally aligned SWNTs on R-Plane Crystal Quartz

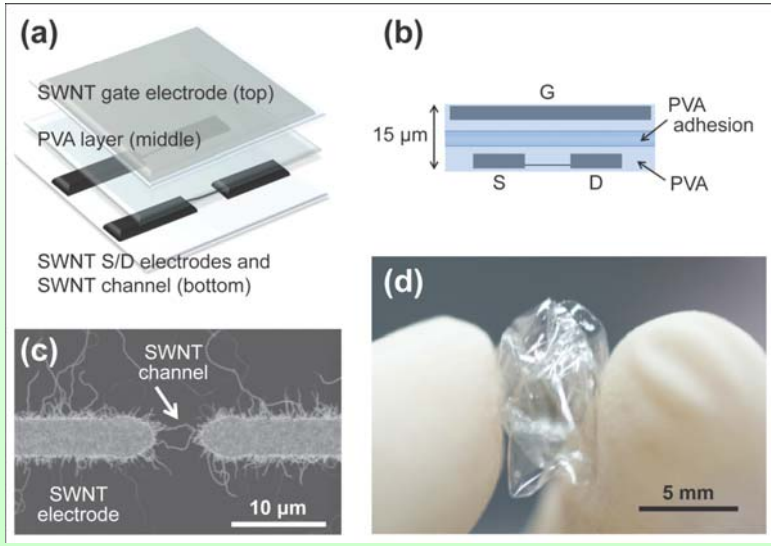
N2 inside VA-SWNT with D < 1 nm



Diameter Control of VA-SWNT

Octopus Growth





Transparent flexible all CNT FET