European Network on New Sensing Technologies for Air Pollution Control and Environmental Sustainability - *EuNetAir*

COST Action TD1105

WGs and MC Meeting at LINKOPING, 3 - 5 June 2015

Action Start date: 01/07/2012 - Action End date: 30/06/2016

Year 3: 1 July 2014 - 30 June 2015 (*Ongoing Action*)

CHALLENGES PERFORMING OUTDOOR AIR POLLUTION MONITORING WITH POLYMER NANOCOMPOSITES

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Introduction

Air quality control

VOC

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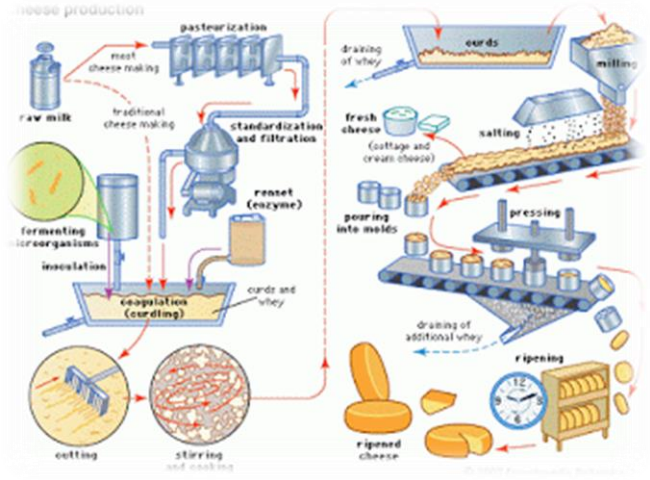
source of information



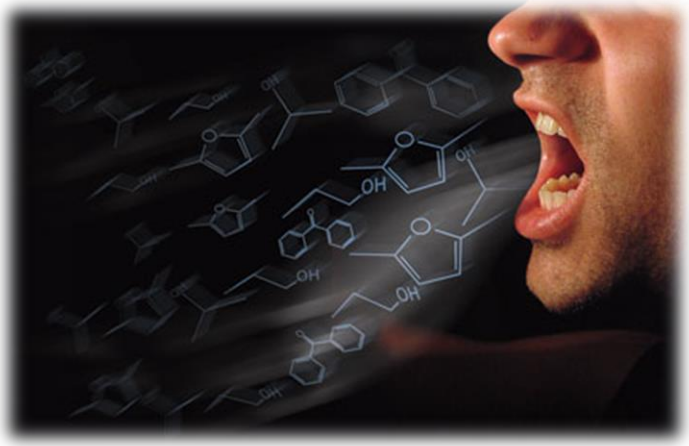
Production process

Temperature

RH

Interference with other gases

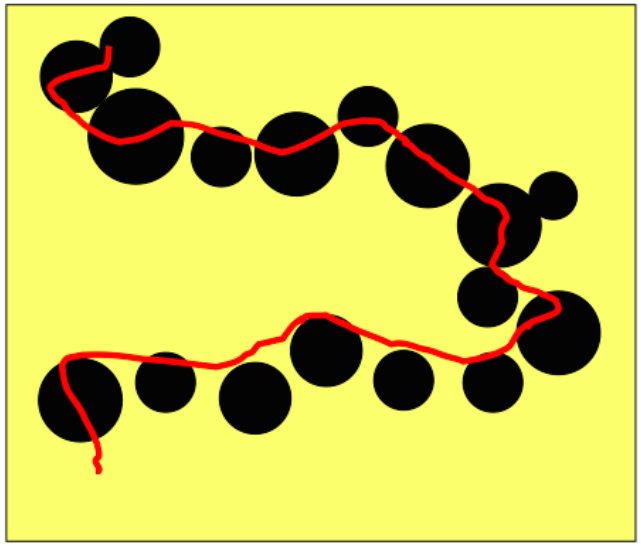
?



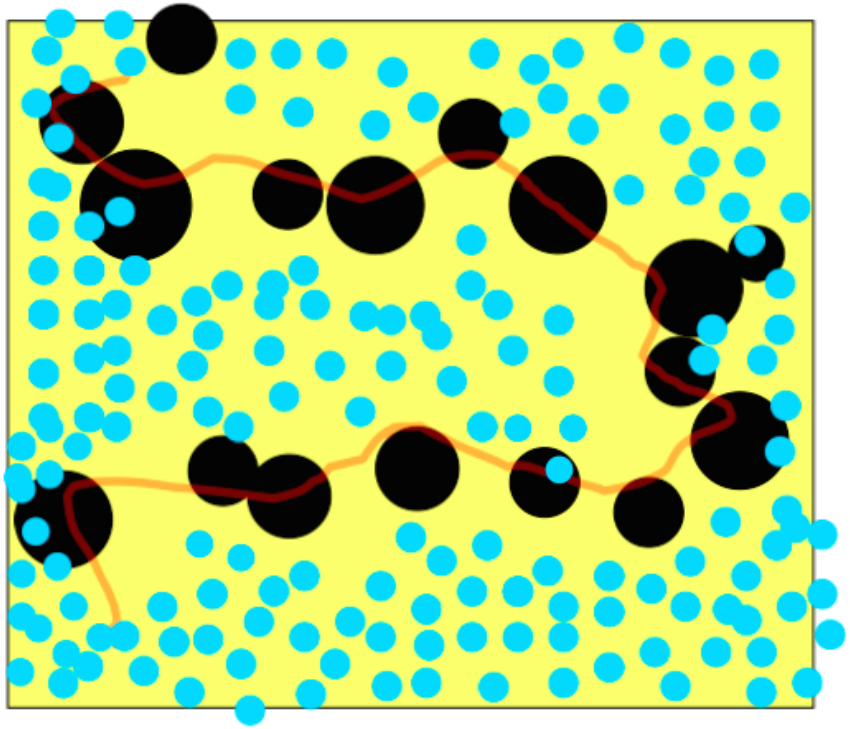
Medicine

Scientific context and objectives

Before exposure



After exposure to VOC

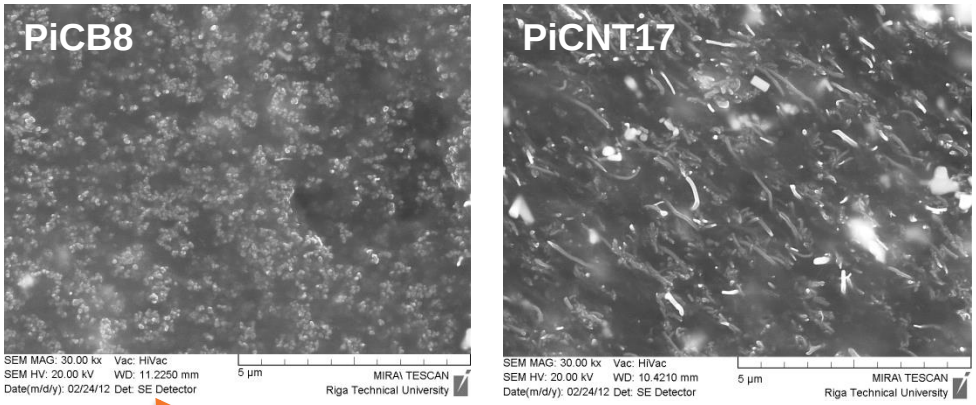


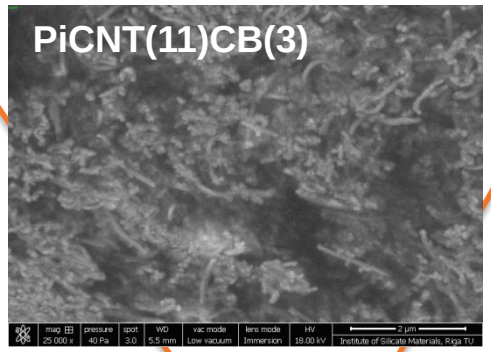
Polymers:
polyisoprene (Pi)
Ethylene-vinyl acetate (EVA) copolymer
Conductive filler:
Carbon nanoparticles (CB)
MWCNT

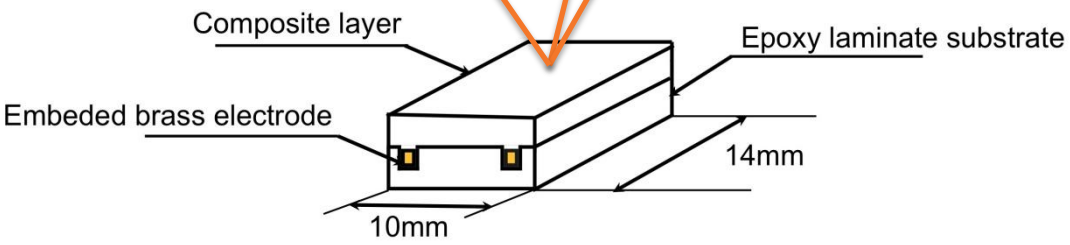
$$\frac{R}{R_0} = \frac{s}{s_0}\exp\left[\gamma(s - s_0)\right]$$

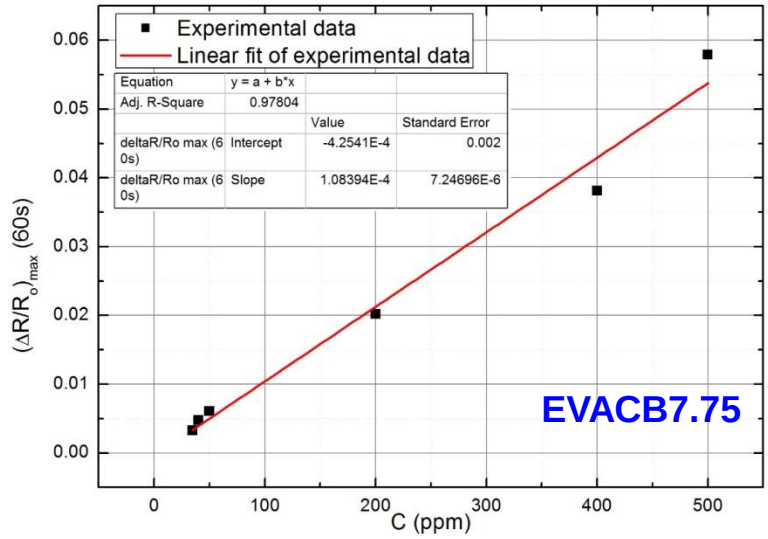
G. Sakale, D. Jakovlevs, I. Aulika, M. Knite
J. Nano Res. 21 (2013)

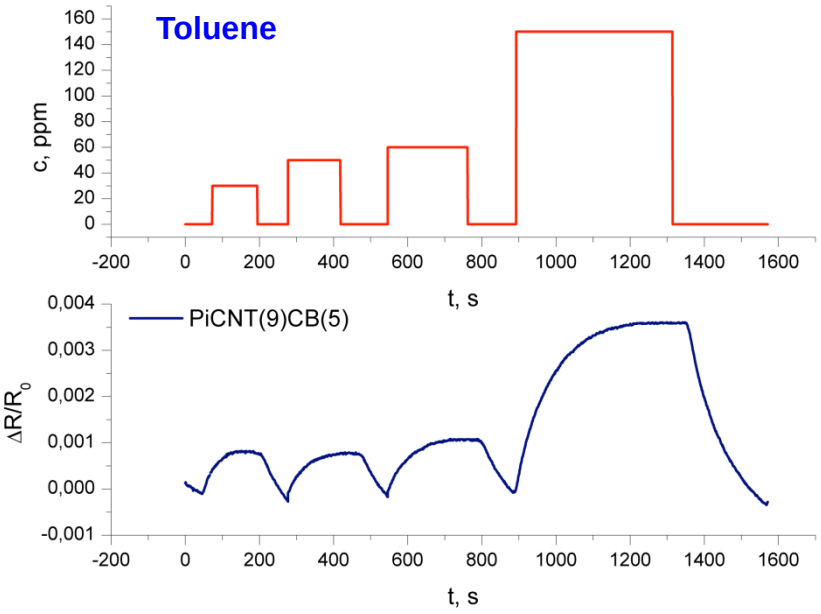
Current research activities (1/2)





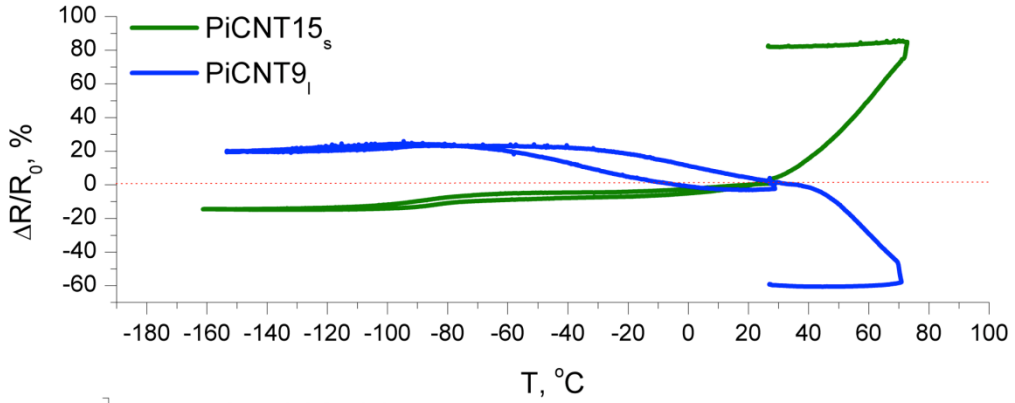


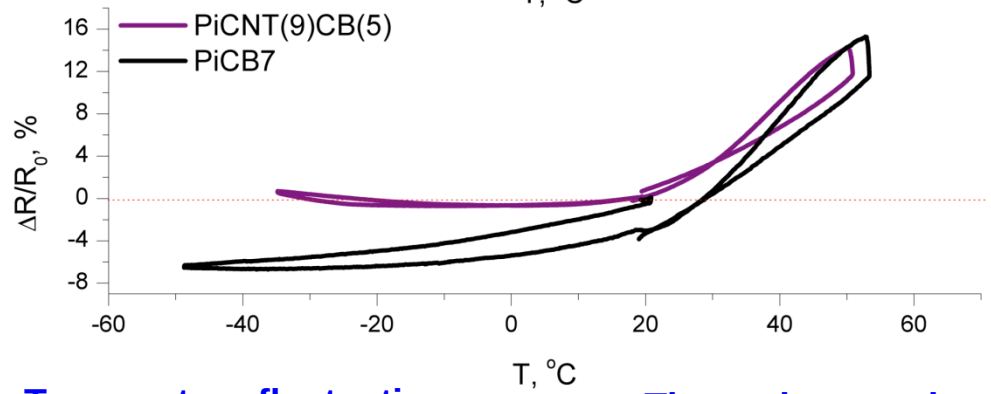


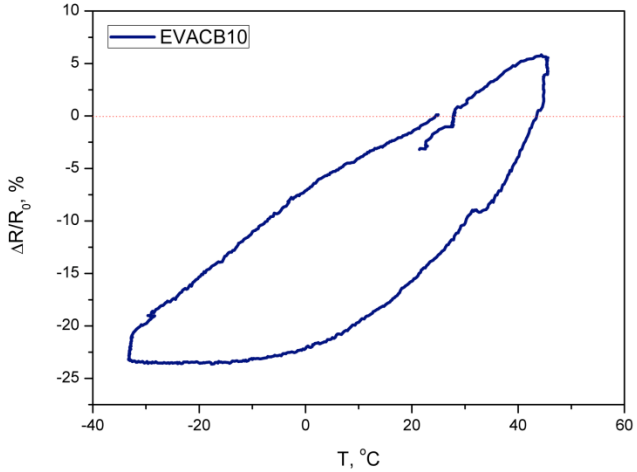


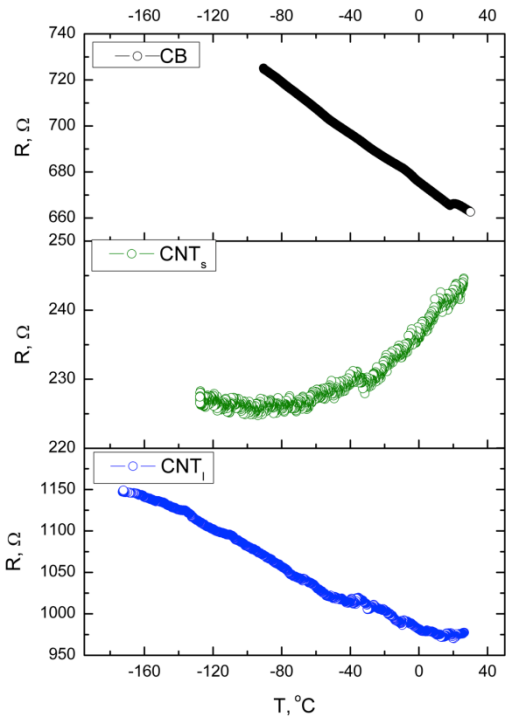
Achieved results (1/2)

Temperature impact on electrical resistance









Semiconductor like

Metalic like

Semiconductor like

Temperature fluctuations induced tunneling, T << T_{room}

$$r = r_0 \exp\left(\frac{T_1}{T + T_0}\right)$$

Sheng Phys. Rev. B 21 2180 1980

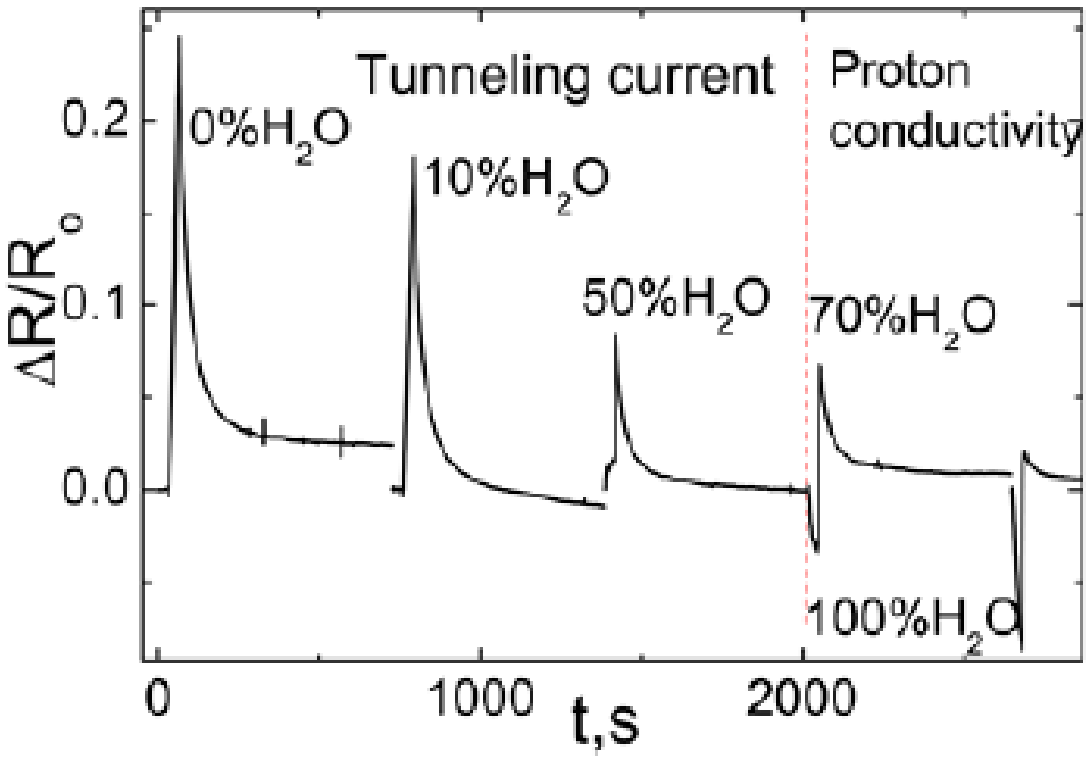
Thermal expansion of polymer, T >>T_g

$$\ln \rho = \ln \rho_{01} + A_0 \alpha \Delta T$$

Polymer 58 (2015) 209-221

Achieved results (2/2)

RH impact on sensitivity

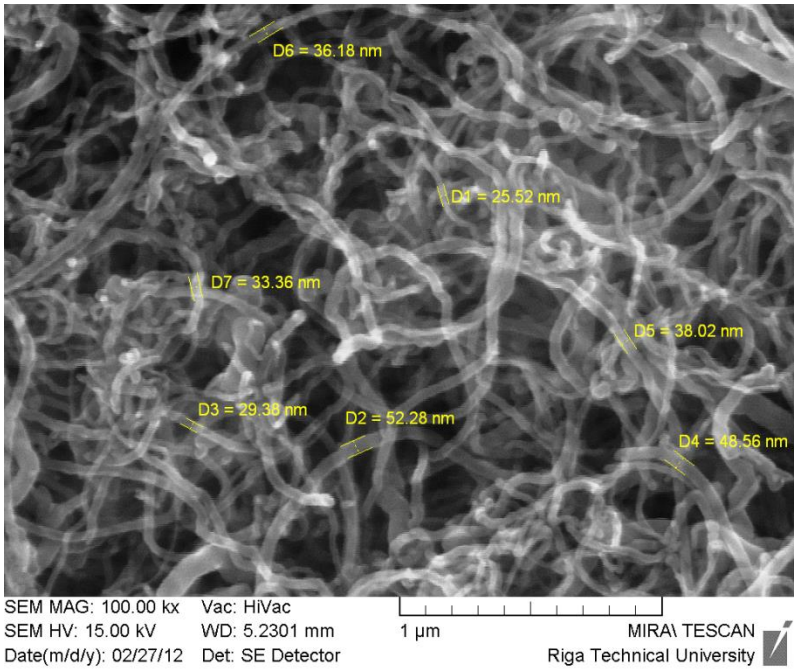


Sensitivity of EVACB8 composite to ethanol

S.Stepina, G.Sakale, M.Knite, IOP Conf.Series: Materials Science and Engineering 49 (2013) 012017

Facilities available (1/2)

Bruker Vertex 70 FTIR spectrometer with ATR module



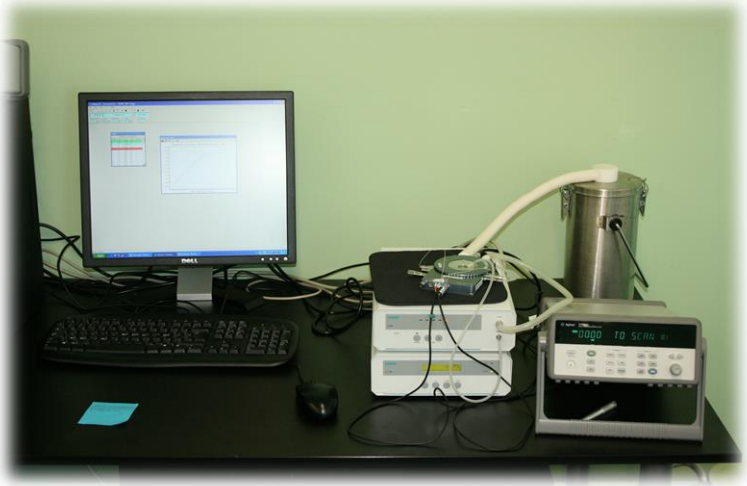
SEM Tescan Mira/LMU with EDS by RTU Deparment of General Chemical Engineering

RENISHAW inVia Raman Microscope

Facilities available (2/2)

FlexStream™ Automated Permeation Tube System

Agilent 34970A (~100MΩ) and Keithley 6487 picoampermeter (~10^{-16}Ω)



Linkam THMSE 600 low and high temperature conductivity measurement system (-190ºC to 600ºC)

BW GasAlertMicro 5 PID detector

Conclusions

- Type of used conductive filler considerably impact the sensor R vs. T character. If fillers are combined in the composite temperature dependence can be diminished.
- At high relative humidity values (> 50%) proton conductivity starts to dominate over conventional electrical resistance change mechanism related to tunneling current decrease between conductive particles due to polymer swelling.

Future perspective and needs:

- **At gas station box reduce RH value at least below 50%.**
- **Field tests with a purpose to detect VOC.**
- **Use silicon rubber as polymer matrix for the sensor (better aging resistance, good gas permeability).**

Acknowledgement
This work was supported by ESF Grant Nr. 1DP/1.1.1.2.0/13/APIA/VIAA/030