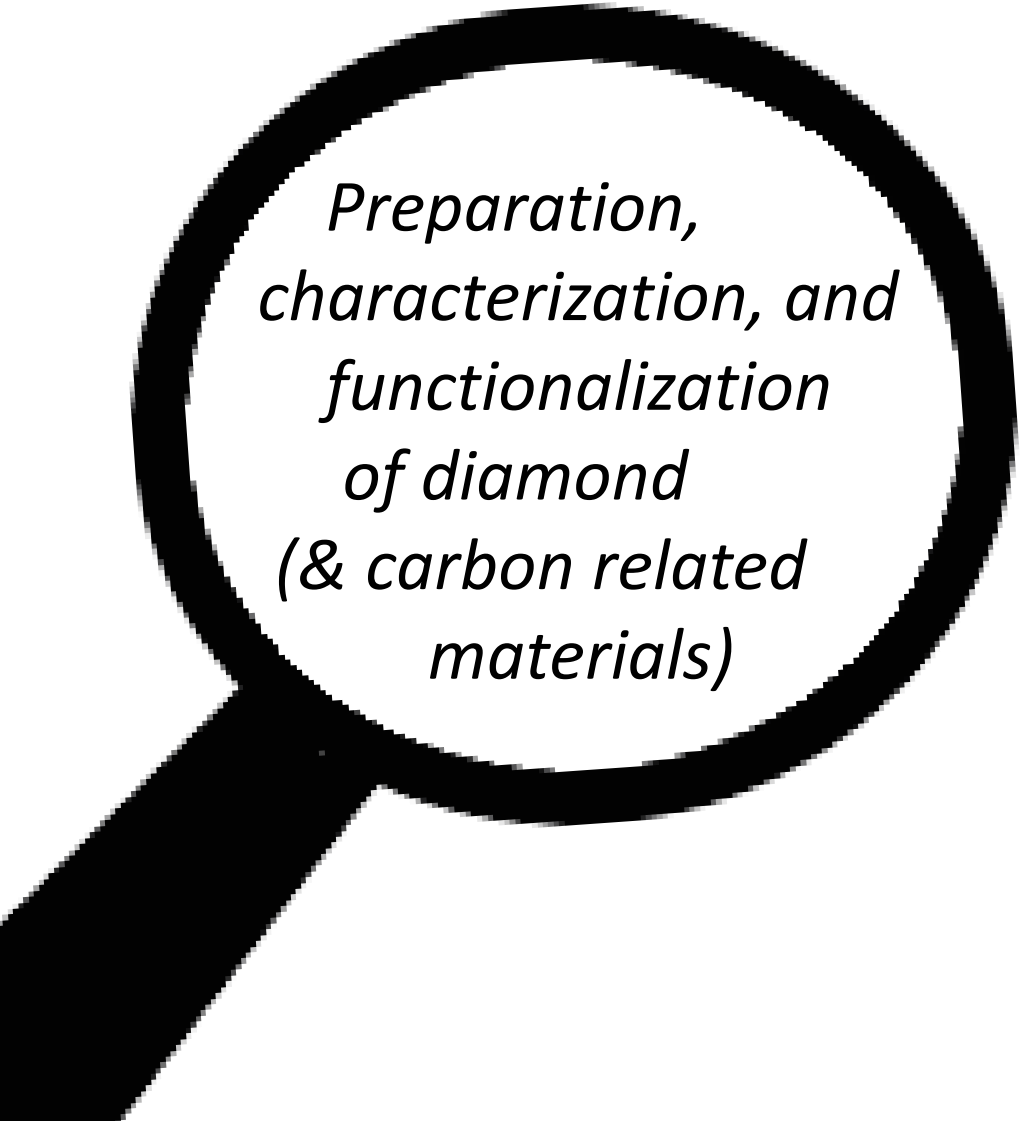
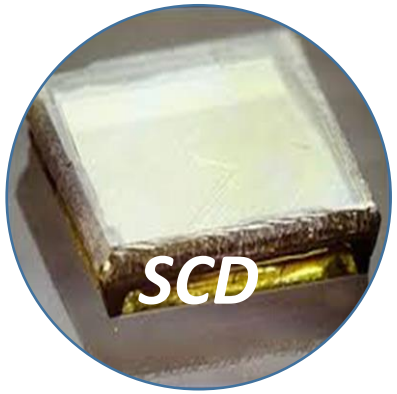
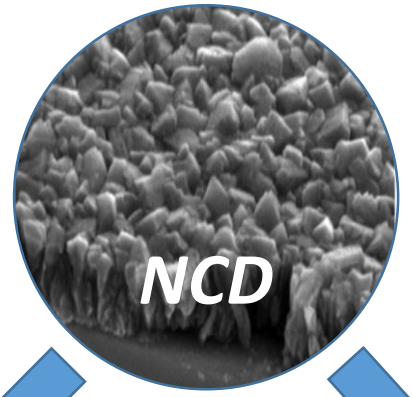
Materials for Nanosystems and Biointerfaces Research Group



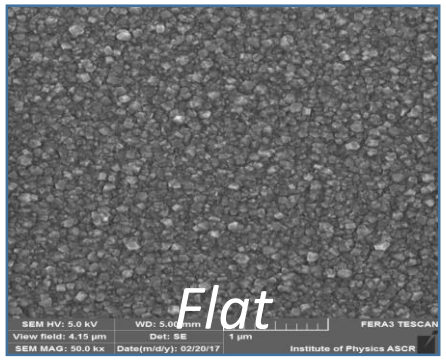
- ***Dr. V. Mortet, Ph.D***
  - Dr. P. Ashcheulov, Ph.D.
  - Dr. M. Davydova, Ph.D.
  - Dr. J. More-Chevalier, Ph.D. (part time)
  - Ing. L. Drbohlavová (Ph.D. Student)
  - Ing. S. Sedláková
  - A. Taylor

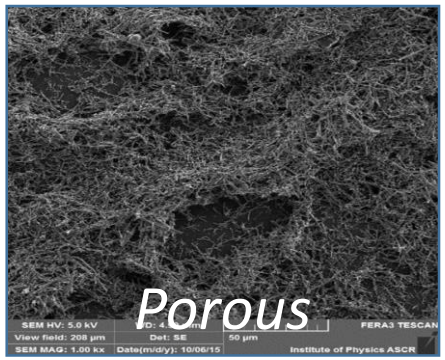
Material synthesis studies



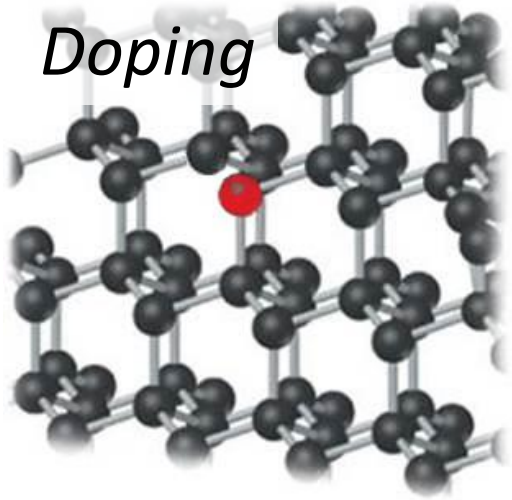


2016

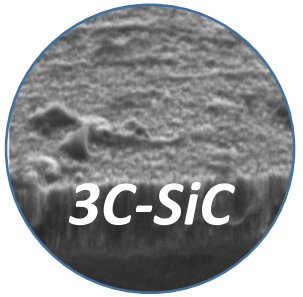




Doping



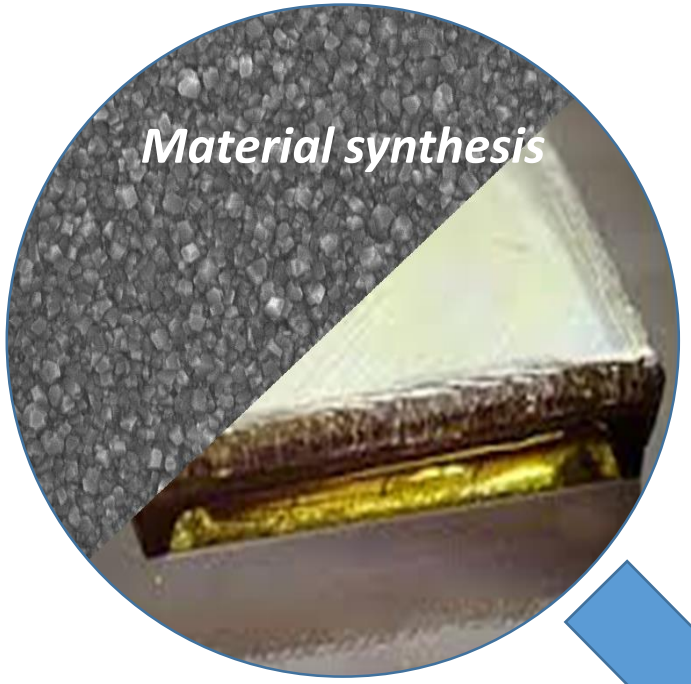
Boron ⇨ *Phosphorous, (Silicon, Nitrogen)*



⇨ *Nano-particles*

⇨ Electronic, electrochemical and micro-electro-mechanical system applications

Characterization and functionalization



Micro technologies

Surface treatment, electrochemistry, micro-biology,…

Applications and devices

- E/C electrodes & (bio) sensors
- Microelectronic: diode, MOS,…
- MEMS: SAW, membranes, cantilevers

Report on material processing & applications

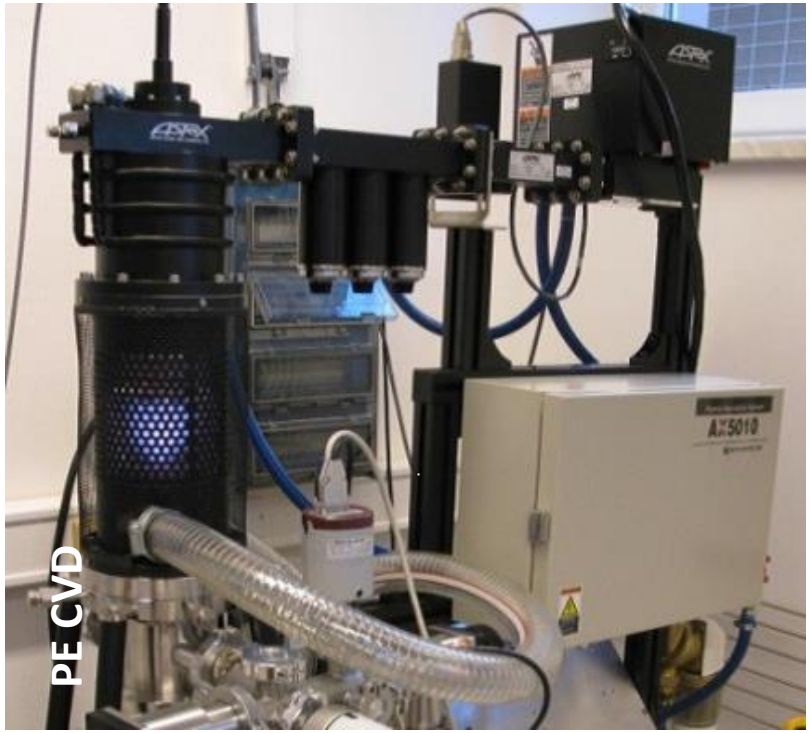
Material characterization

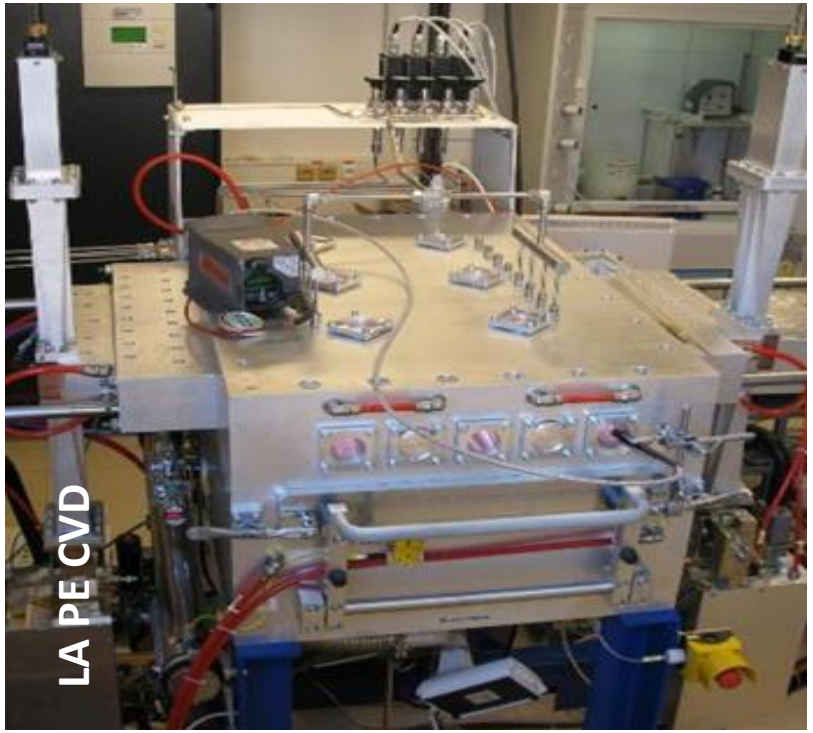
Material properties

e.g. new materials, new properties,…

Report on material synthesis & properties

The Lab...



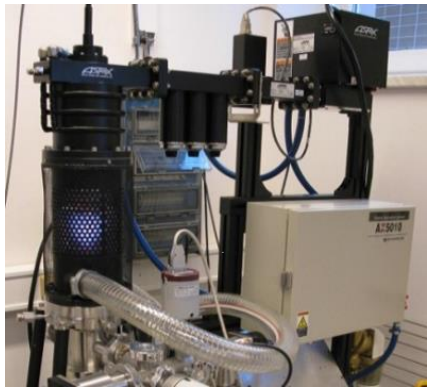


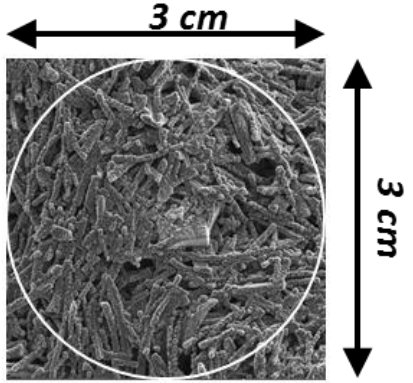
Deposition conditions

Temperature (°C)	> 700	> 250
Pressure (mbar)	10 - 100	< 1
Coating area	< 2 inches	8 inches*
Growth rate (μm/h)	0.1 - 2	0.03 - 0.07

Porous boron doped diamond layers

Seki AX5010





	As grown	Cleaned	E/C grade (Elmt 6)
Substrates	Flat titanium, silicon, glass		-
Diamond layer resistivity	10-60 mΩ.cm	(10-60 mΩ.cm)	20-200 mΩ.cm
Max number of layers (N)	6	12	n.a. (Flat)
Thickness*	4-5 μm/layer	4-5 μm/layer	50 μm
Sheet resistivity*	c.a. 100/Layer	60-200/Layer	-
Roughness factor*		c.a. 7.3/layer	-
Specific capacitance	-	c.a. 11 μF/cm^2	< 20 μF/cm^2
Potential window	c.a. 1.7 V (2.0 V)	c.a. 2.7 V	> 3 V
Substrate surface	1 cm^2 (sq)	9 cm^2 (sq)	130 cm^2 (disk)
Active area		400 (800)**	130 cm^2
(Price)	-	-	(65 Euros/cm^2)

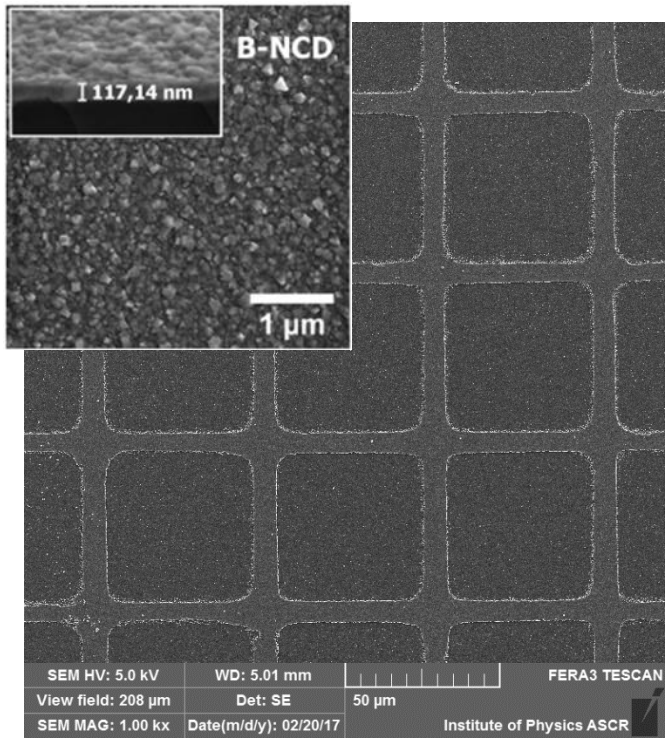
Use of a SO2 fiber template ⇨ replacement by conductive fiber template

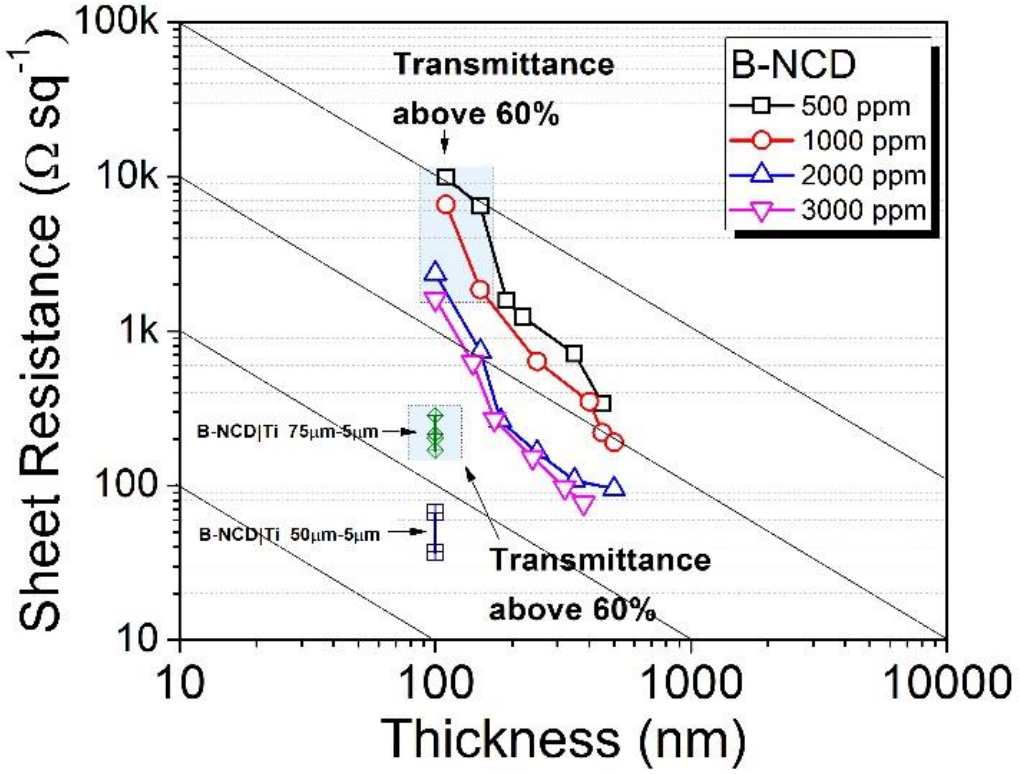
V. Petrak et al., Carbon 115 (2017) 457, Czech patent application (Ref. E274894)
"Způsob výroby porézní diamantové vrstvy a tlustá porézní diamantová vrstva vyztužená nanovlákny"

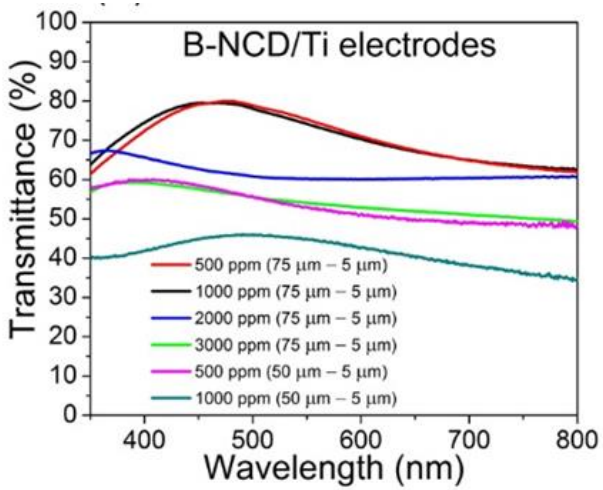
* Function of number of layers;
** for 6 and (12) layers

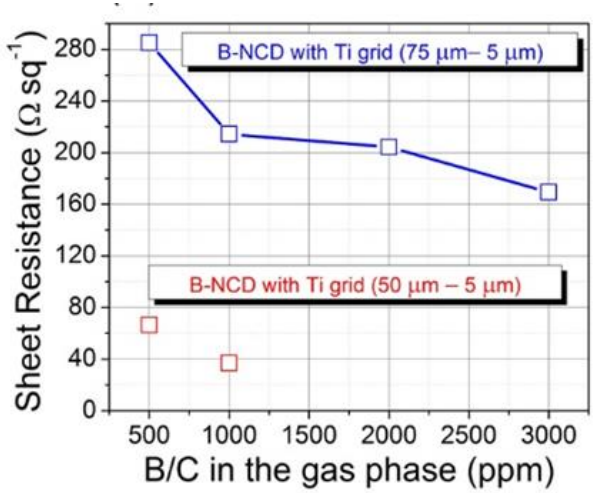
Optically transparent titanium grid/diamond composite electrodes

B-NCD|Ti B-NCD Ti grid





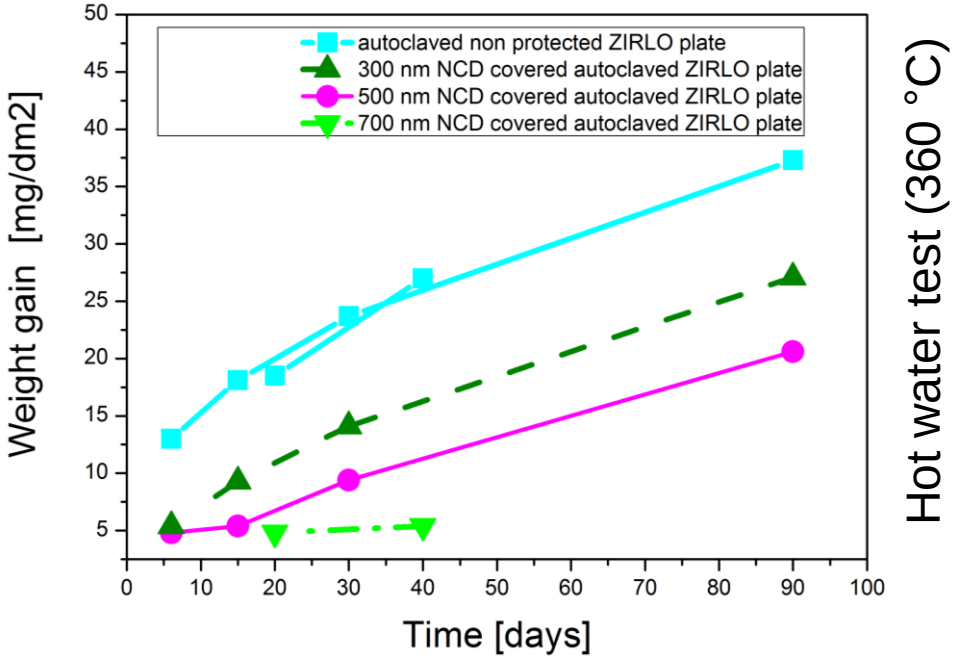


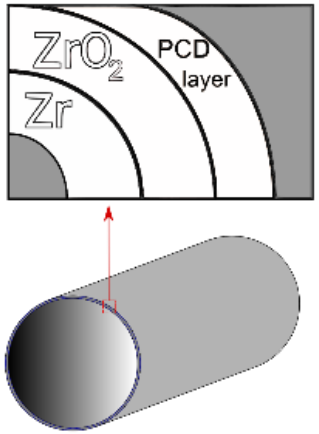


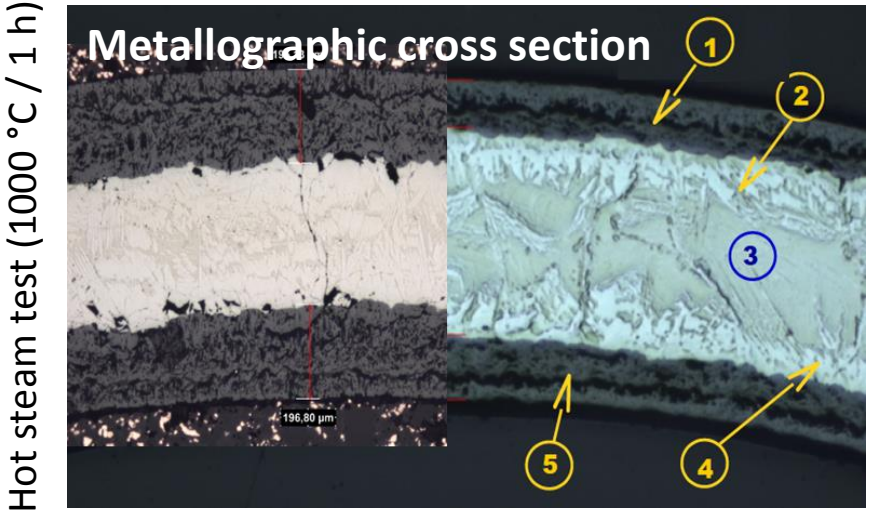
P. Ashcheulov et.al. Optically transparent composite diamond-Ti electrodes submitted to Carbon journal

Protective coating of Zr alloys nuclear fuel rods

I. Kratochvílová, P. Ashcheulov







w/o diamond with diamond

(1,4) Zirconium dioxide layer

(2,5) Oxygen-stabilized zirconium α phase

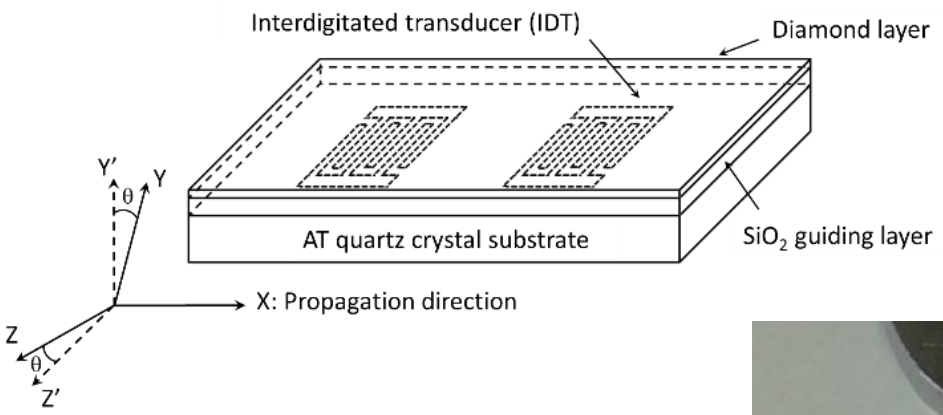
(3) Initial Zr β phase

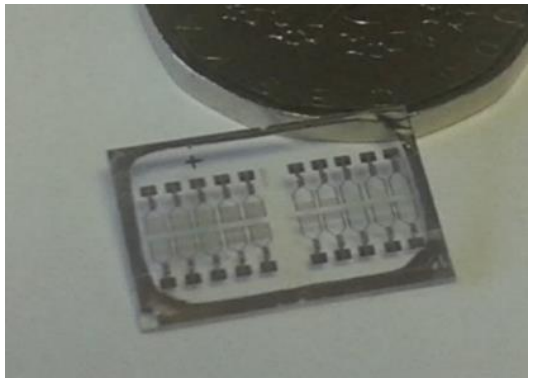
Nanocrystalline diamond protects Zr cladding surface against oxygen and hydrogen uptake: Nuclear fuel durability enhancement submitted to ***Nature Scientific Reports***

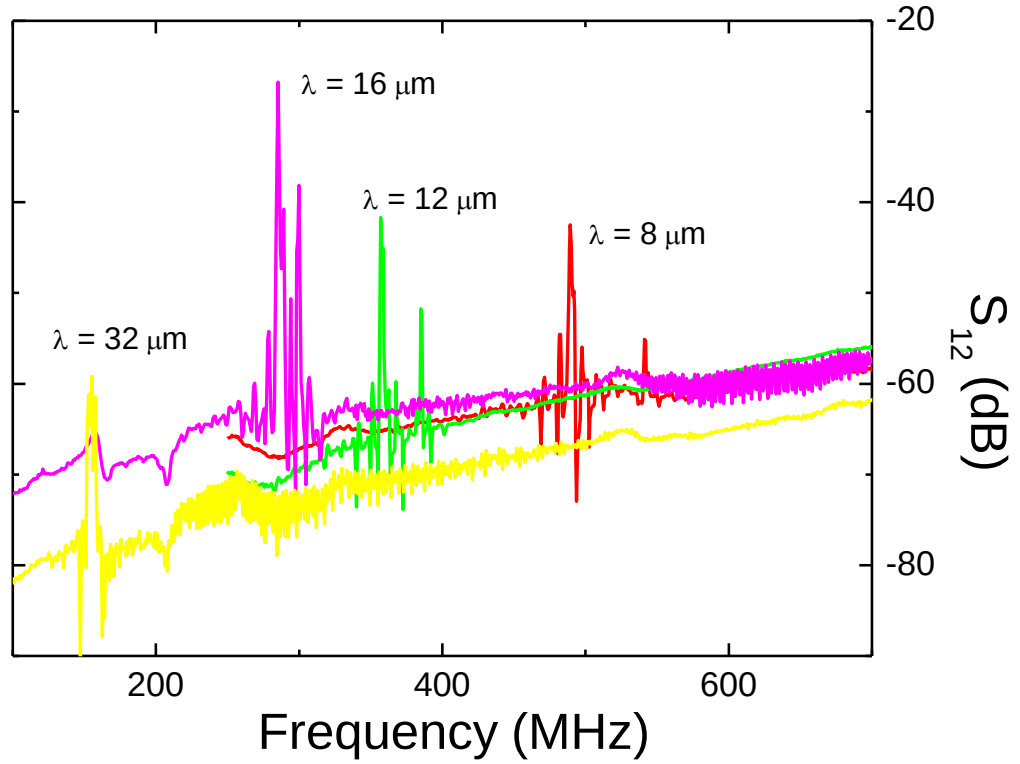
Development of biosensors for bacterial detection

- ***Transduction principle***

- **Diamond coated surface acoustic wave (SAW) sensors**
- **Electrochemical sensors (diamond electrodes)**

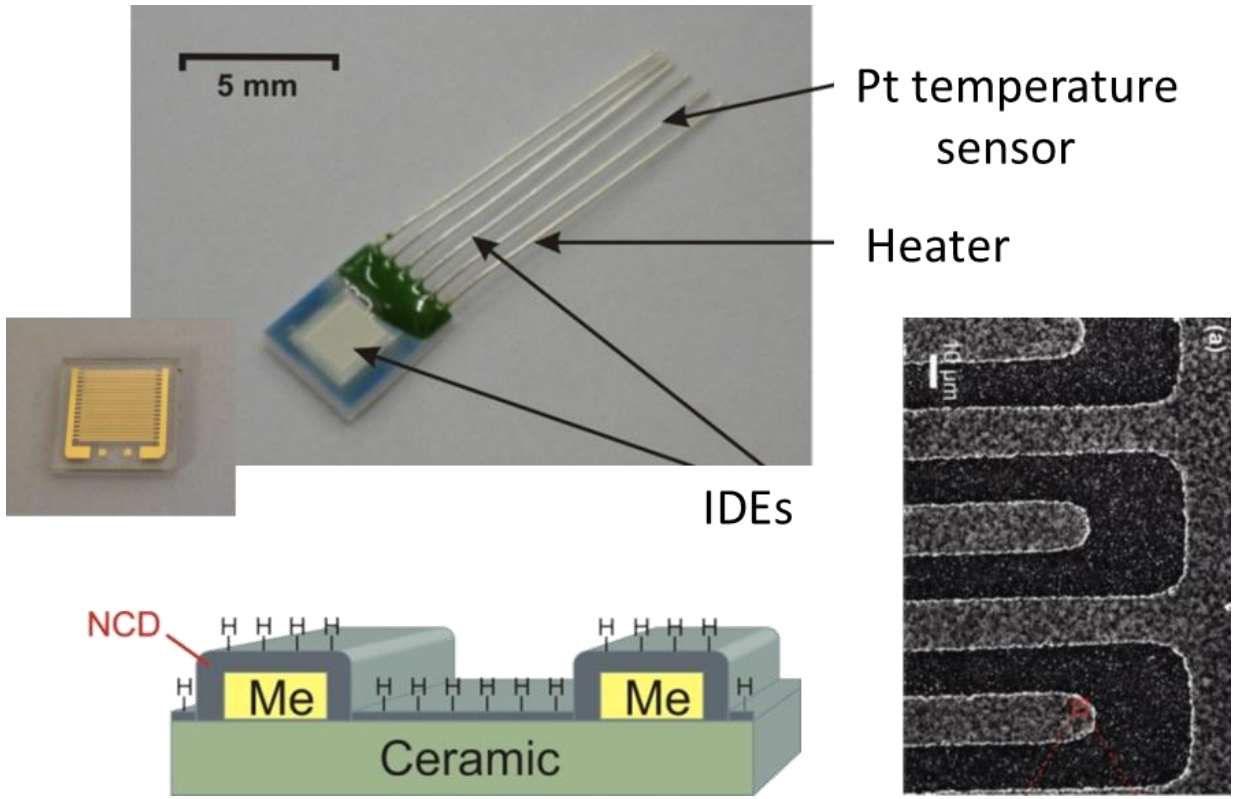


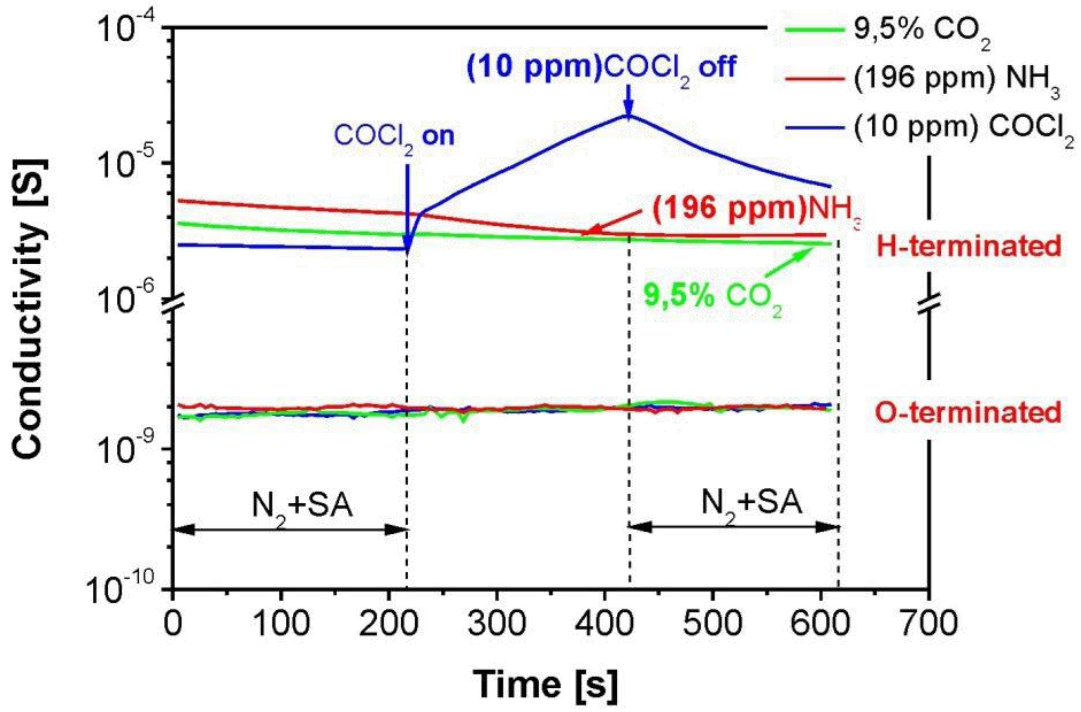




- A. Talbi et al. Physica Status Solidi A 212 (2015) 2606
- L. Brbohlavova, "Development of SAW sensor platform for pathogen detection" Master Thesis, 2016.

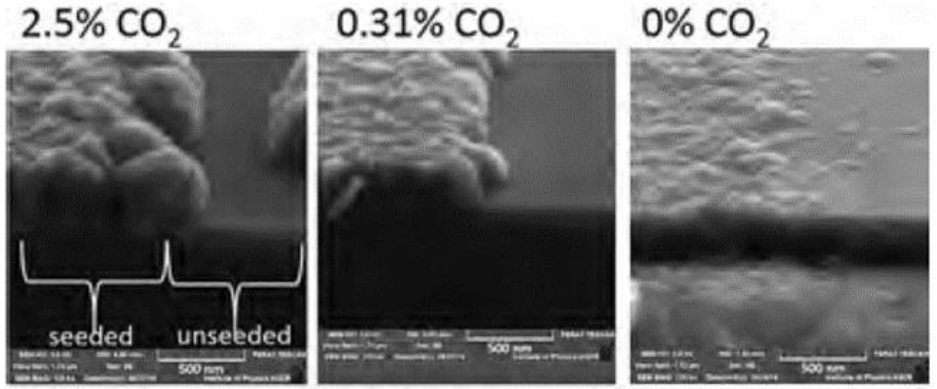
Gas sensing properties of nano-crystalline diamond

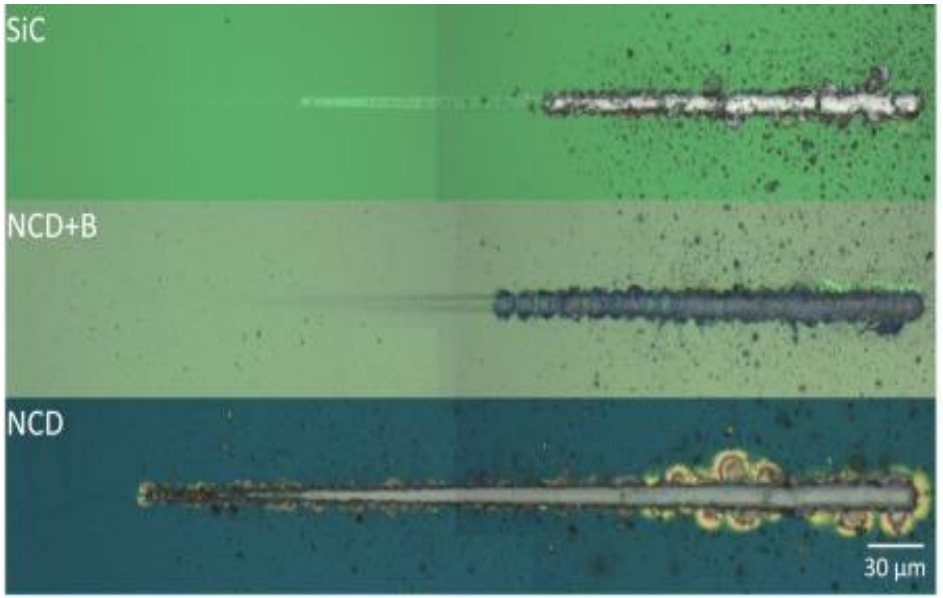


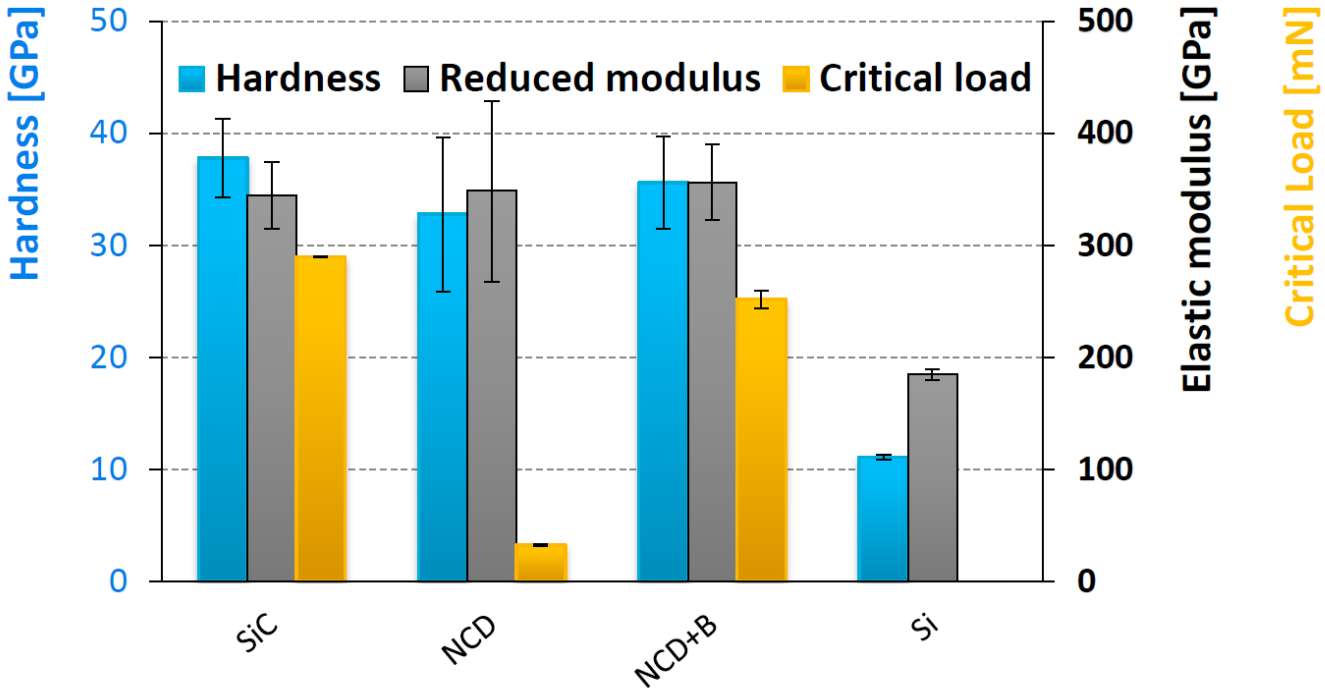


Time dependence of surfaces conductivity of O- and H-terminated NCD films to different gases.

3C-SiC thin films, comparison to NCD layers



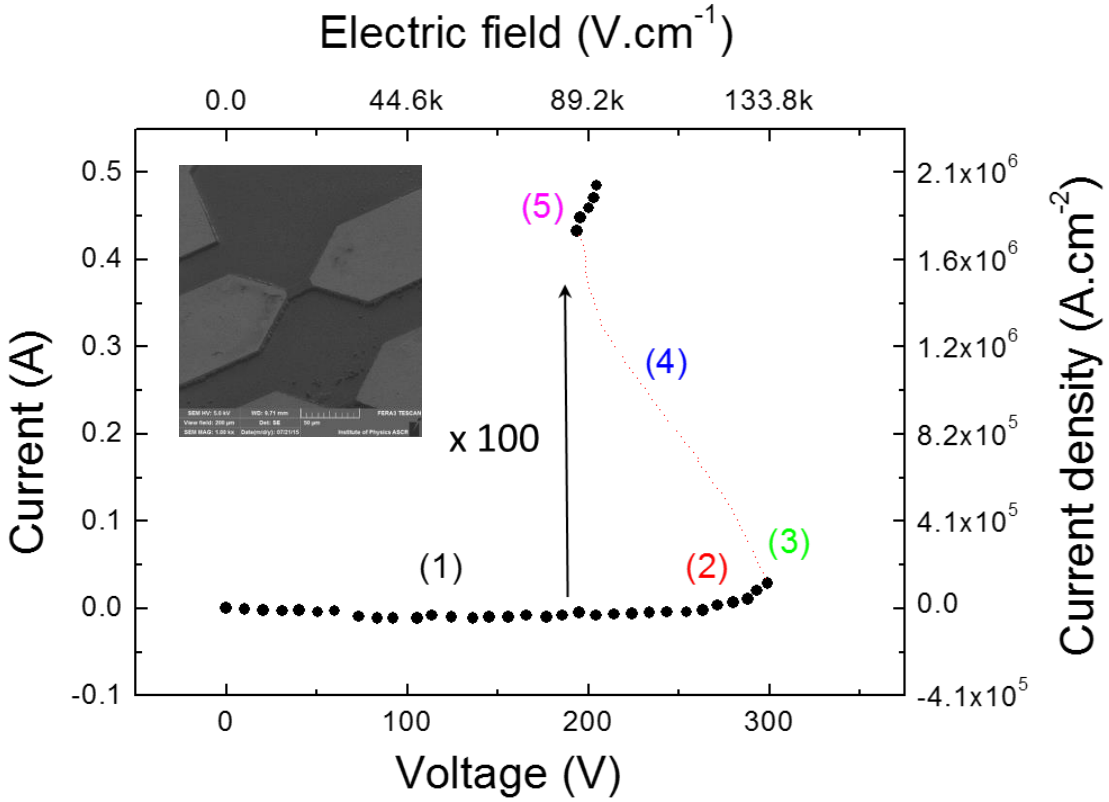


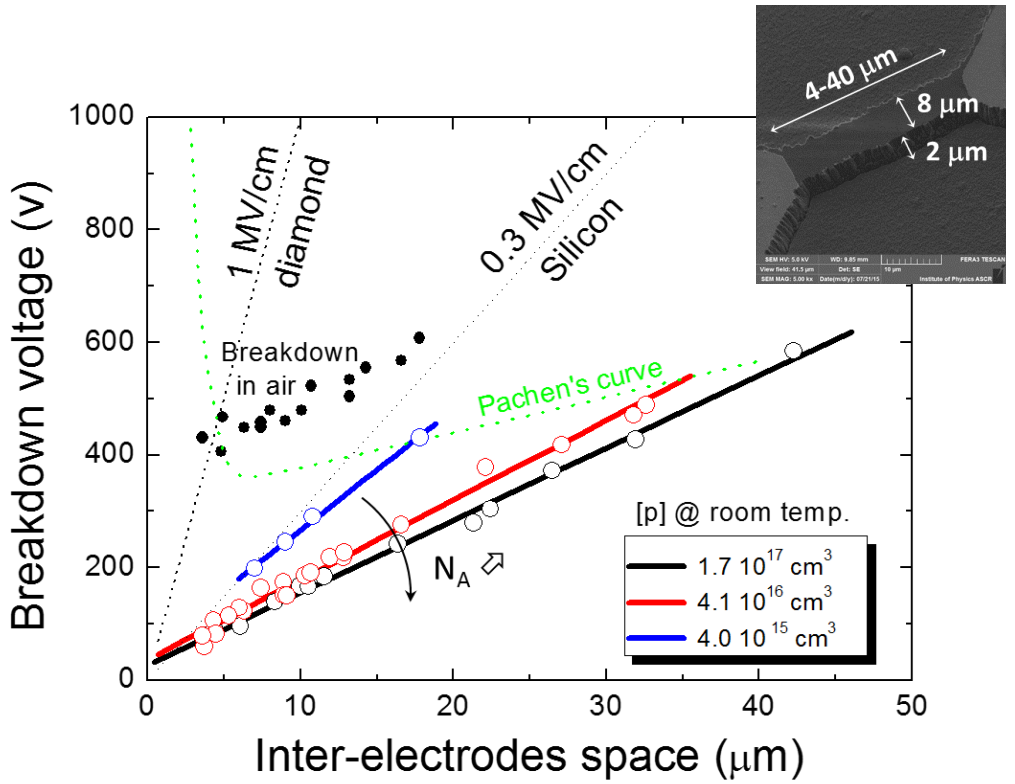


Low surface roughness: R_{RMS} ~ 2nm
High refractive index: 2.40 (x 2.23) @ 600 nm
Wide range transparency

A. Taylor et al. physica status solidi (a) 212 (2015) 2418, A. Taylor et al. Diamond Relat. Mater. 69 (2016) 13

Electrical properties of BDD in high electric field





(1) Ohmic region (Low field) ---High resistivity---

(2) Carrier multiplication (high field)

(3) Breakdown voltage

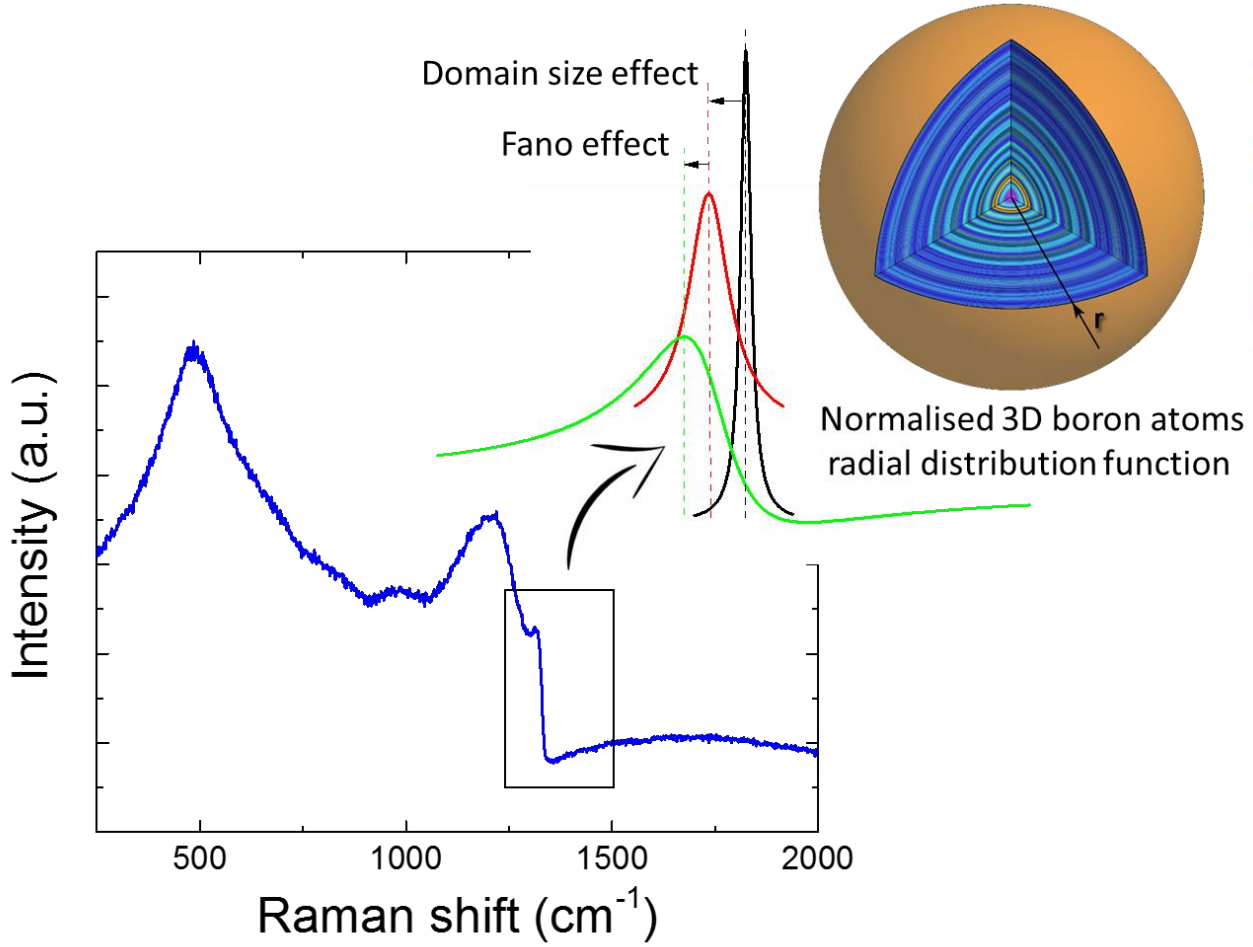
(4) Transient region with negative resistance

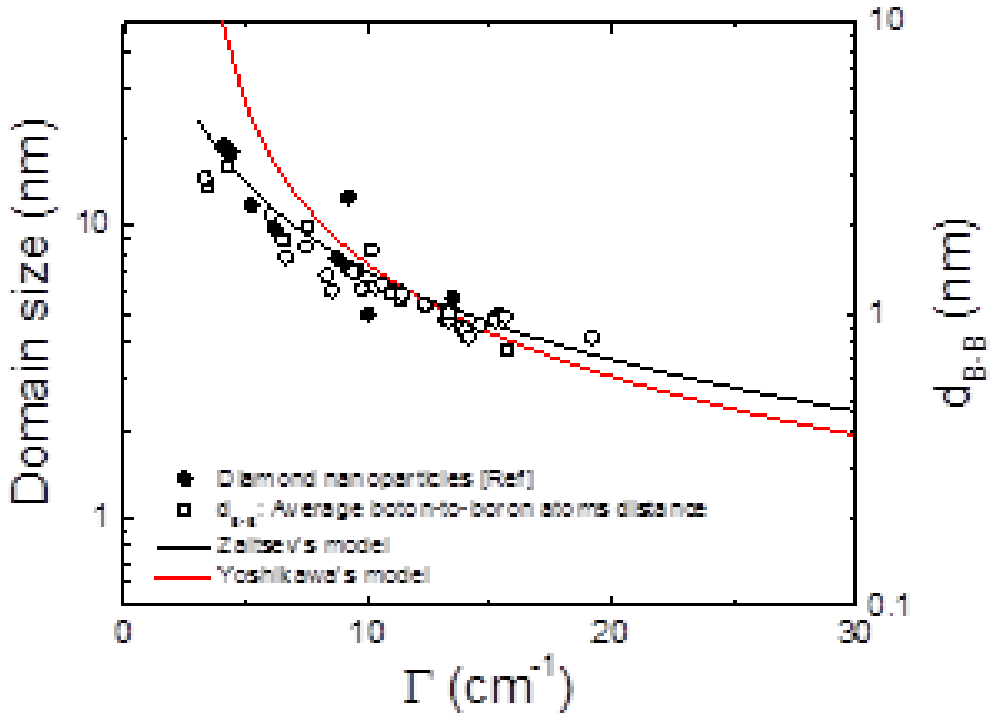
(5) Saturation of ionization rate ---Low resistivity---

Sample	003	001	II-13
[p] (cm^{-3})	1.7×10^{17}	4.1×10^{16}	4×10^{15}
[B] (cm^{-3})	$3\ 10^{19}$	$2\ 10^{19}$	10^{19}
E_B (kV/cm)	128	167	214

V. Mortet et al. Appl. Phys. Lett. 108 (2016) 152106

Raman scattering of boron doped diamond





V. Mortet et al. Carbon 115 (2017) 457, Will be presented at the 11th Conference on New Diamond and Nano Carbons

Outlook of main research directions

- Development of porous diamond layers for E/C applications
- Development of bio- & chemical- sensors
- Study of doped diamond properties in high electric field
- Development of large area diamond coating
- Study of Si/C composites deposition