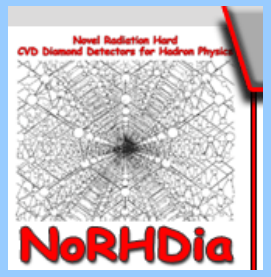


Homo-epitaxial growth and characterization progress in Saclay

N. Tranchant, M. Nesladek, P. Bergonzo

Darmstadt 2006

Agenda

- Motivation
- Growth parameters
- Results
- Raman’s spectroscopy
- Diamond View & FTIR
- TOF & CCE
- X-ray’s measurement

Motivation

Why diamond ?

Radiation's hard

Fast detector → high mobility

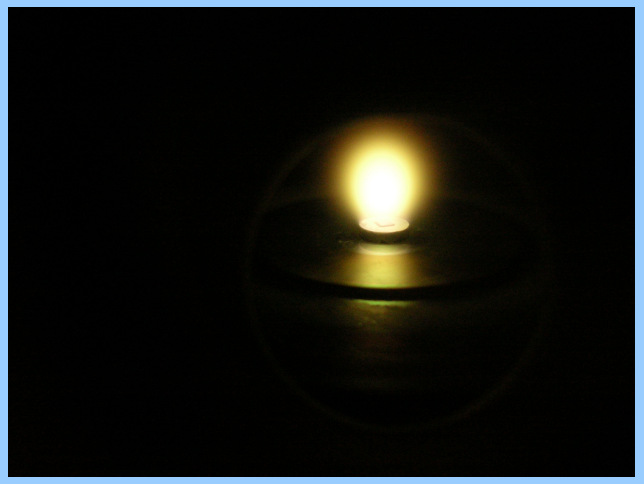
High collection efficiency

	+	-
Si	Availability, size	Quality
3C-SiC	Available size	Lattice parameter
Ir	Lattice parameter	Availability, price
HPHT	Lattice parameter	Price

HPHT's preparation

Chemistry attack :

→ boiling acid
→ rinsing



Plasma etching :

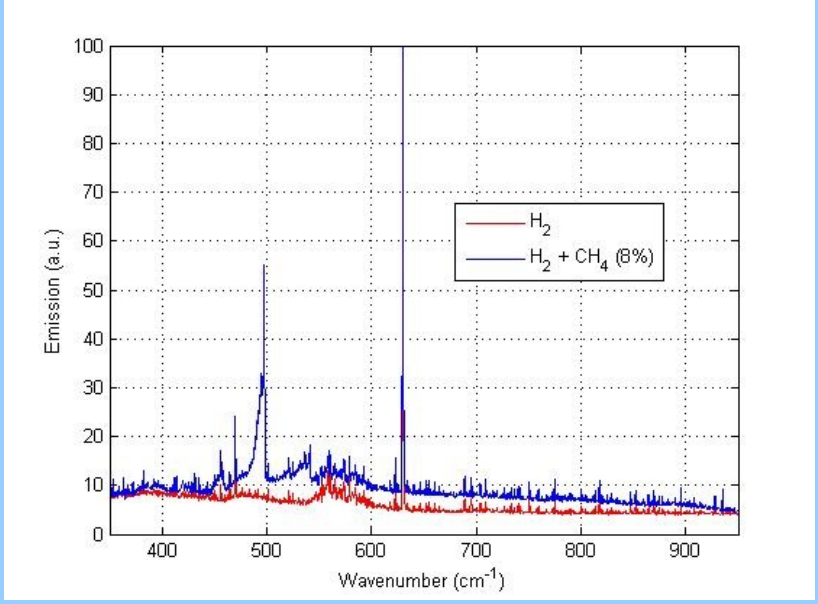
H_2/O_2 (4%)
µ-wave power 1kW
Set period 1^h

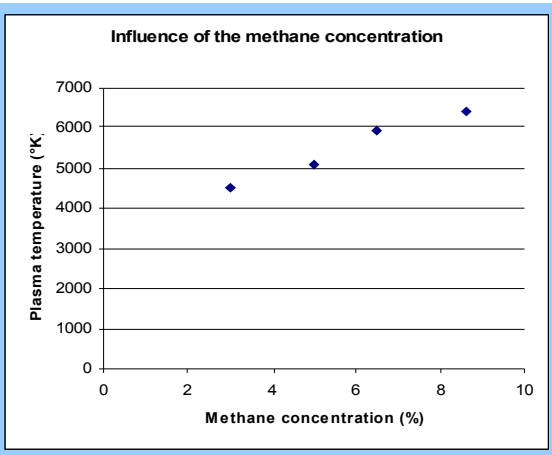
Growth Parameters

MW power	→	from 500 to 800W
Gas Pressure	→	from 160 to 300 mBar
Temperature	→	roughly 920°C
CH4 (%)	→	from 2 to 10%

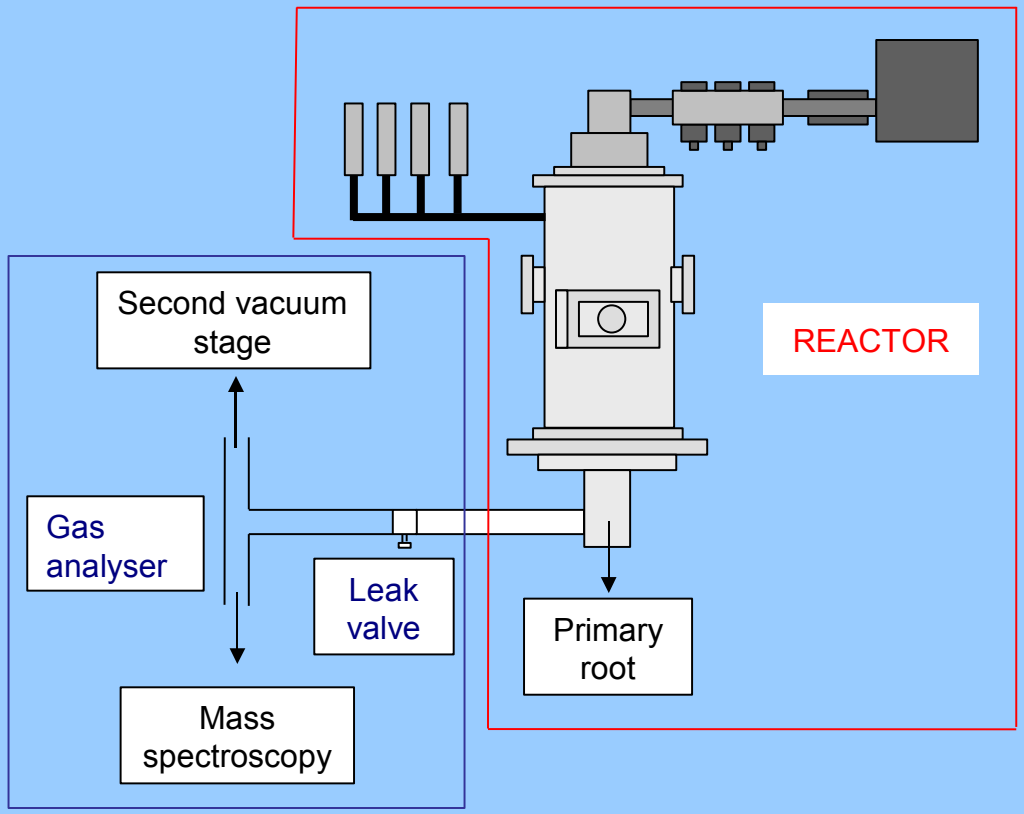
In situ characterizations

OES





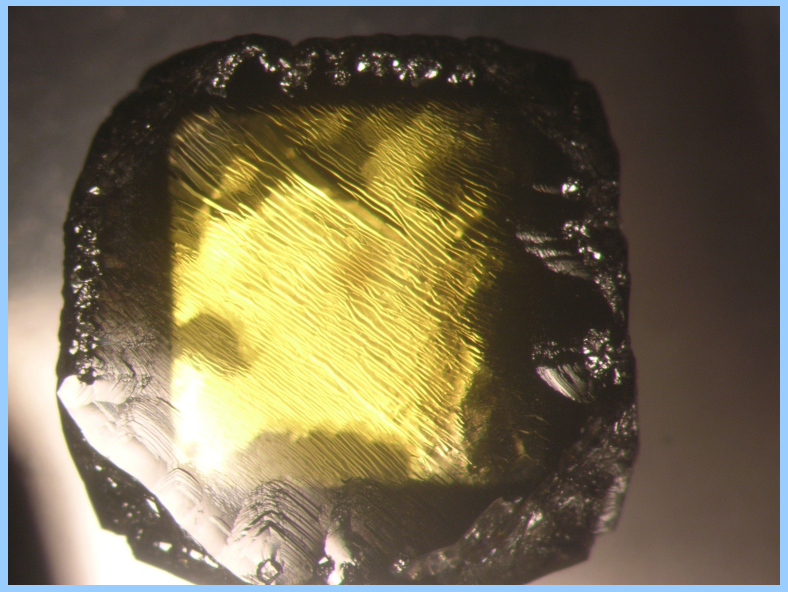
Gas analysis



No nitrogen detected in the chamber

Laser cutting & polishing

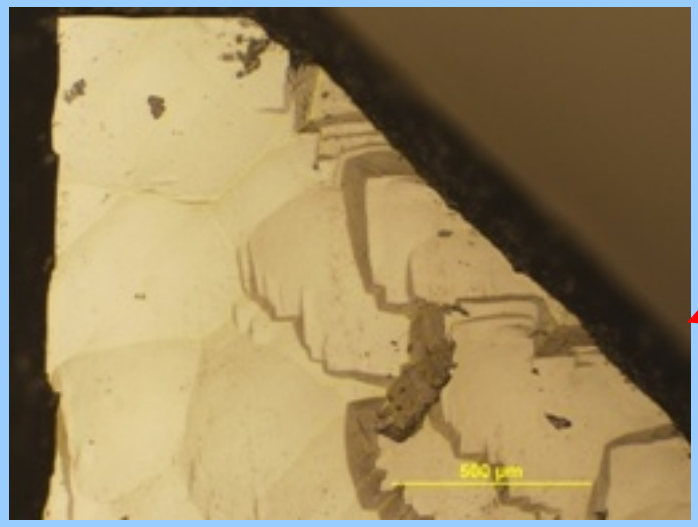
After growth



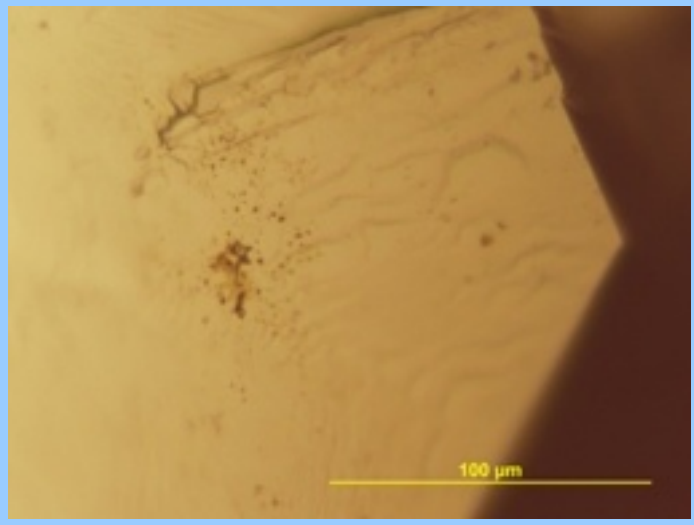
After polishing

Results → optical microscope

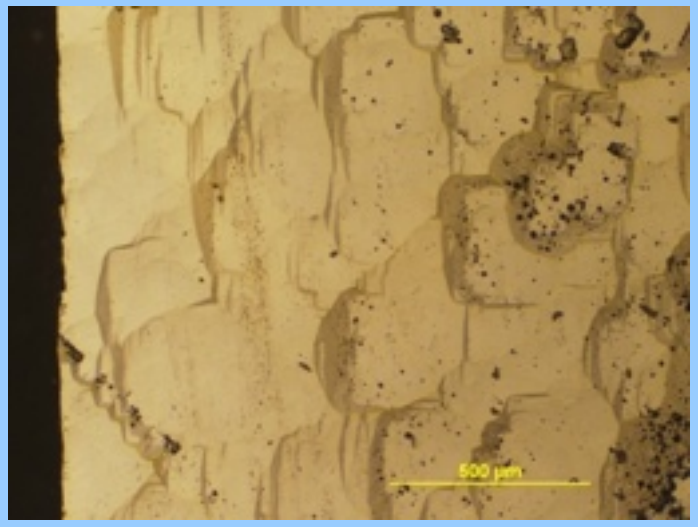
Different morphology according to the experimental setup :



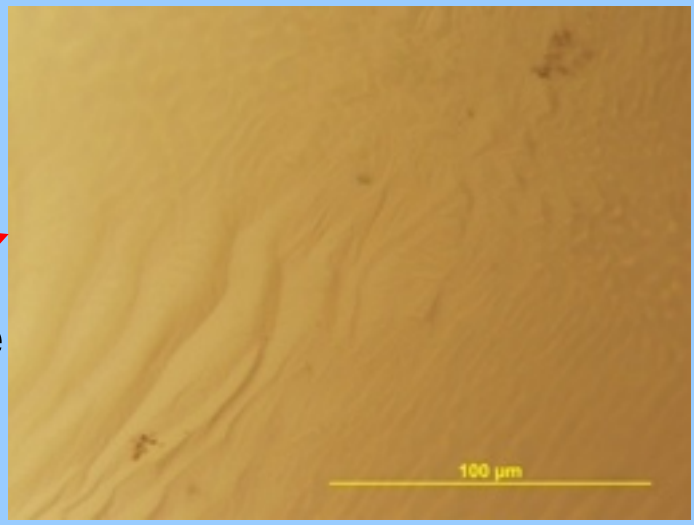
Rough surface
Terraces



Control growth mechanism



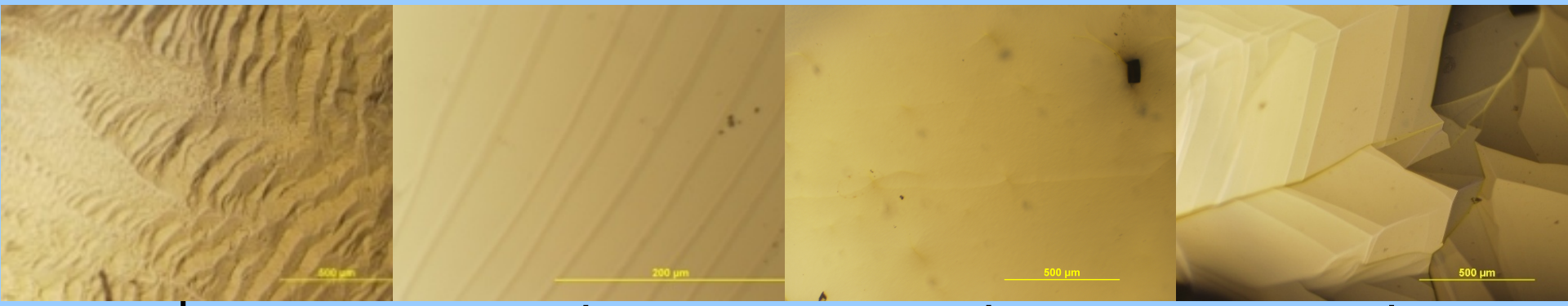
Flat surface
Lower growth rate



Results → CH_4 effect

Effects of the CH_4 concentration on the surface roughness

2% 3% 6% 8%

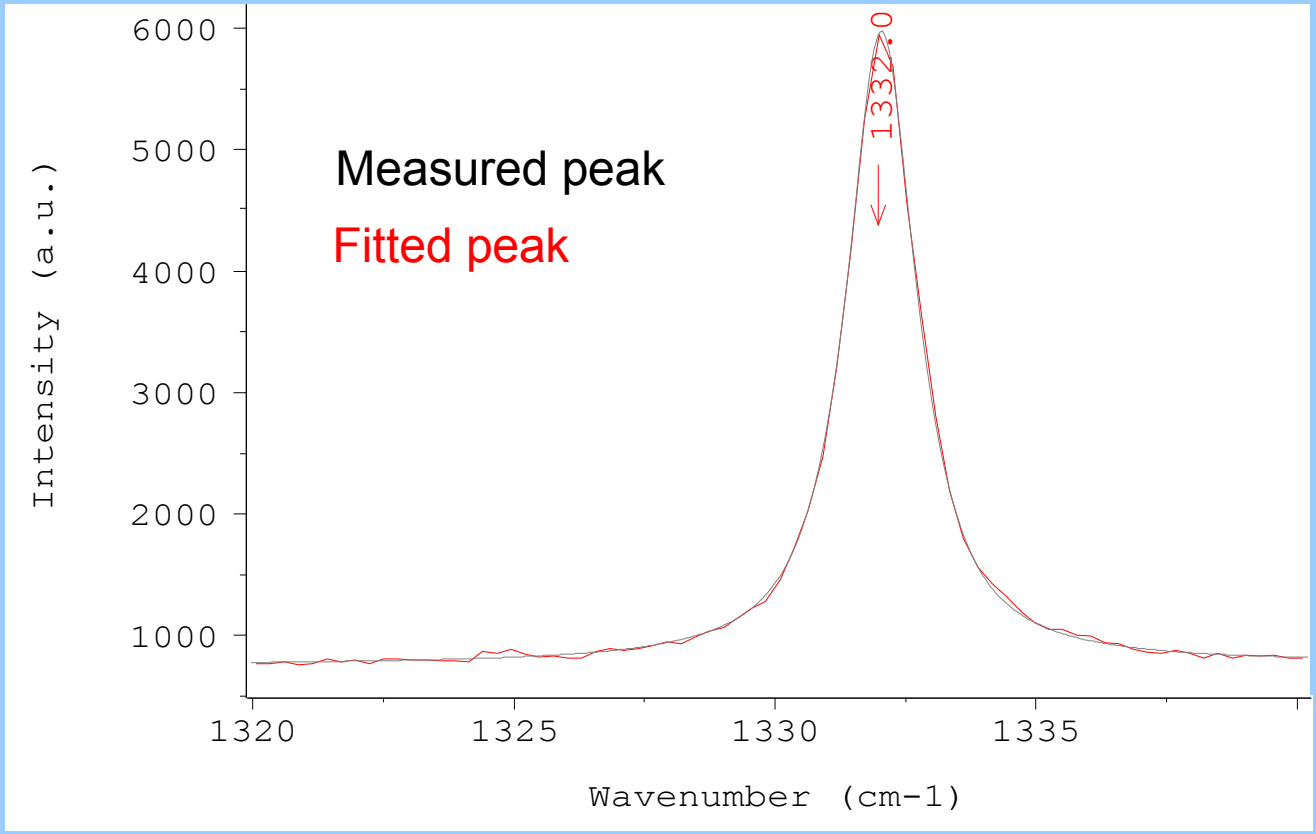


CH_4 concentration

New experiments applying more drastic conditions (340 mBar; 700W) show higher growth rate (20 µm/h) & still a good morphology

Raman's spectroscopy

Confocal Raman →Laser excitation = 514,32 nm



Peak : 1332 cm^{-1}

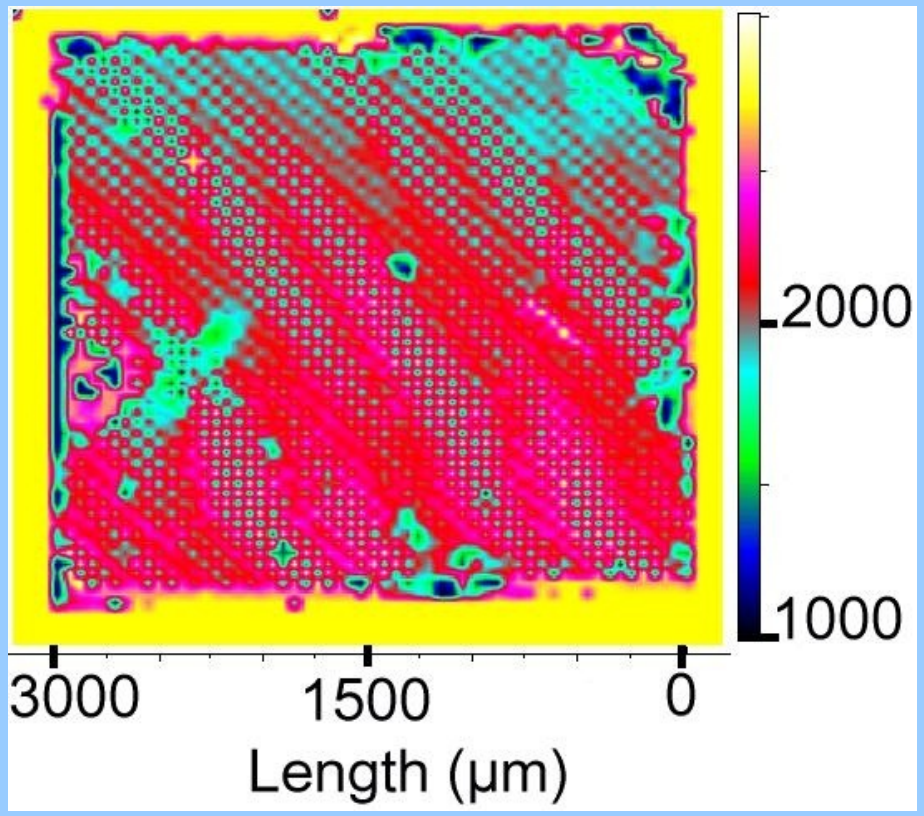
FWHM : 1.6 cm^{-1}

⇒ No internal stress

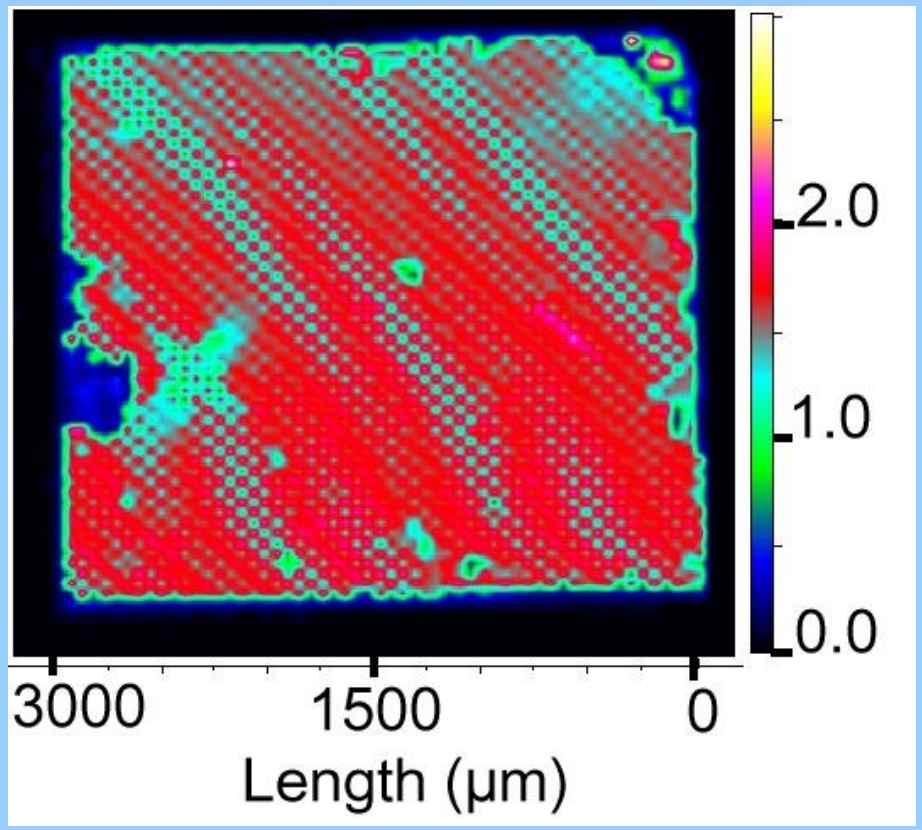
⇒ Only diamond bounds

Raman's mapping

Confocal Raman →Laser excitation = 514,32 nm



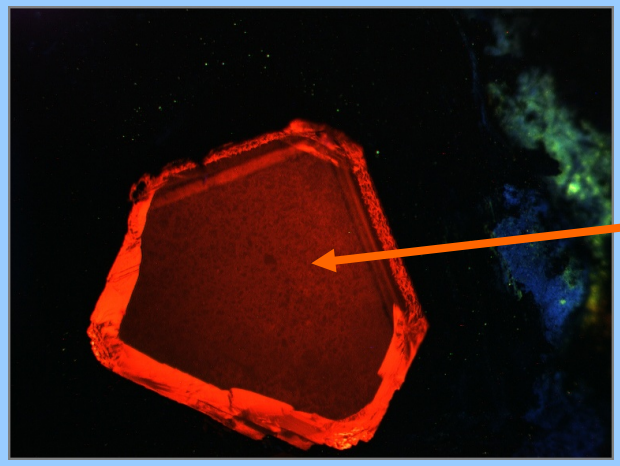
Peak position (cm^{-1})



FWHM (cm^{-1})

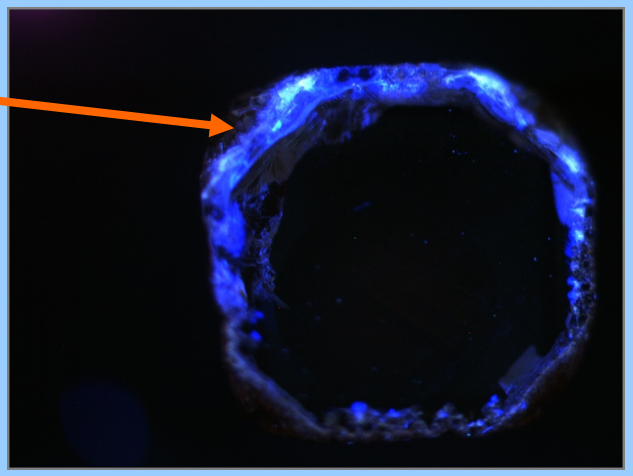
Diamond View

A040506

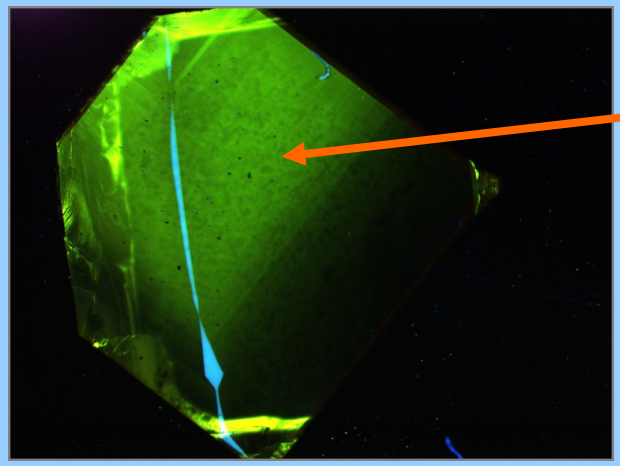


UV-light

N-vacancies
in red

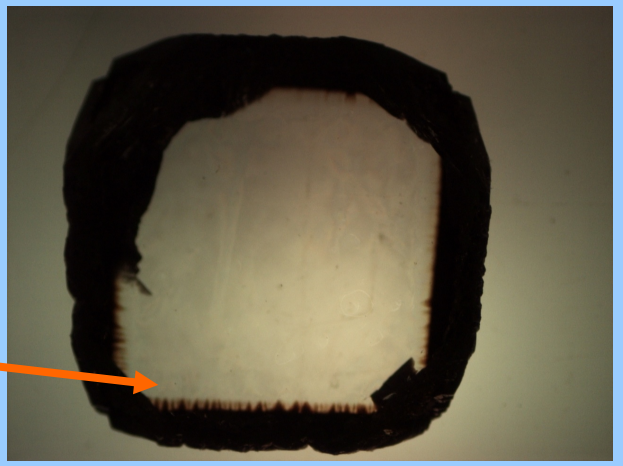


A310605

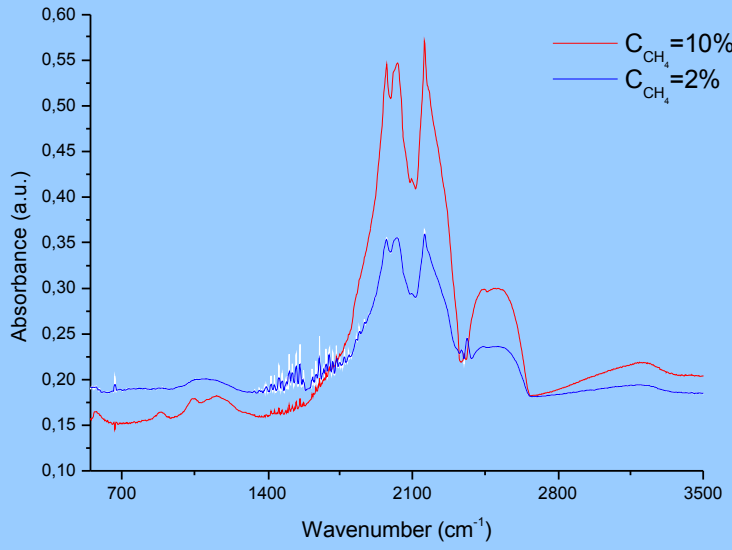
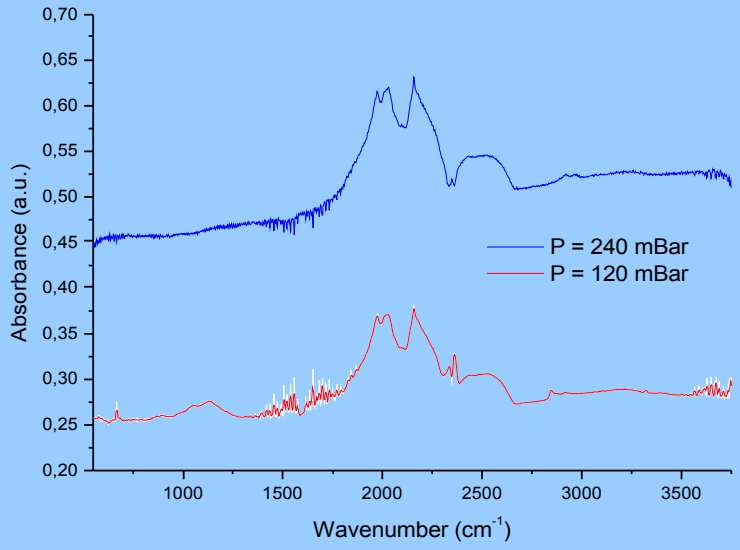


N-interstitials
in green

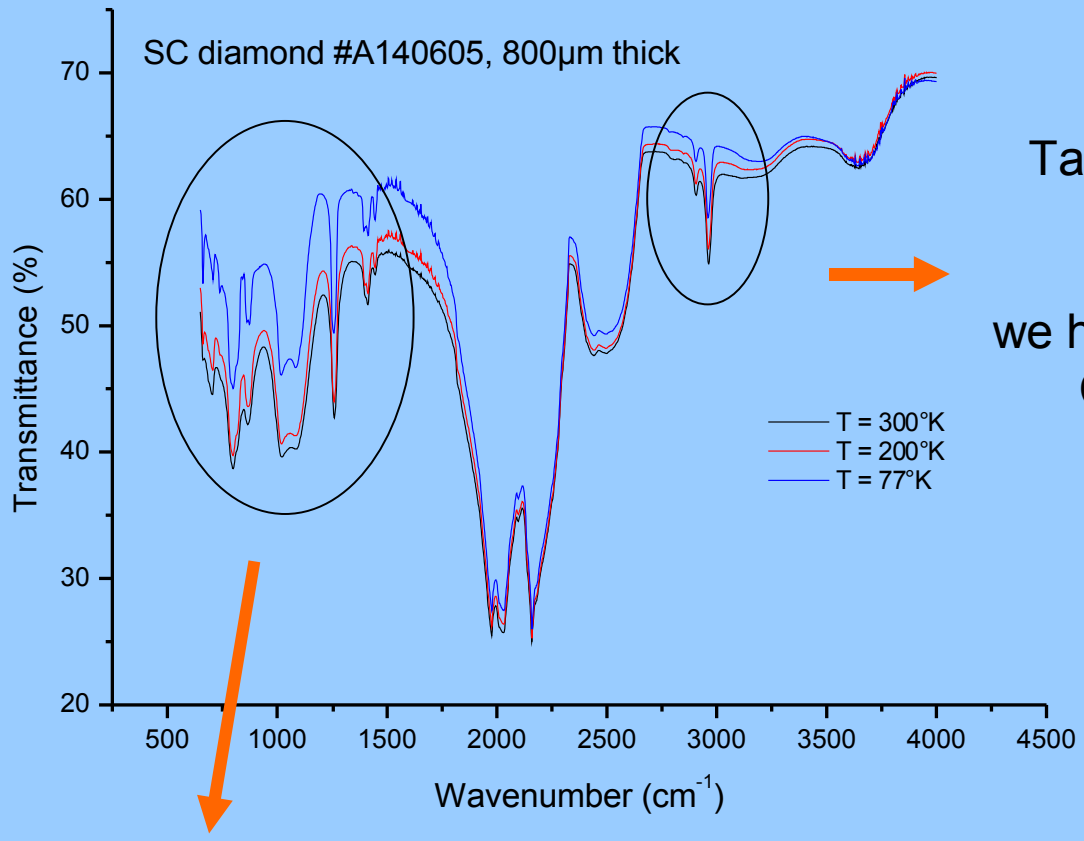
Day-light



FTIR

Increasing CH_4	Increasing the pressure
	

FTIR



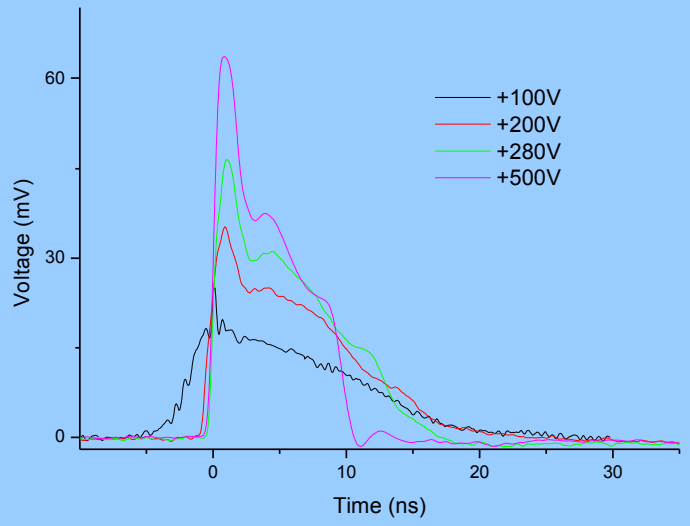
Taking 3000cm^{-1} as absorbance coefficient for diamond :

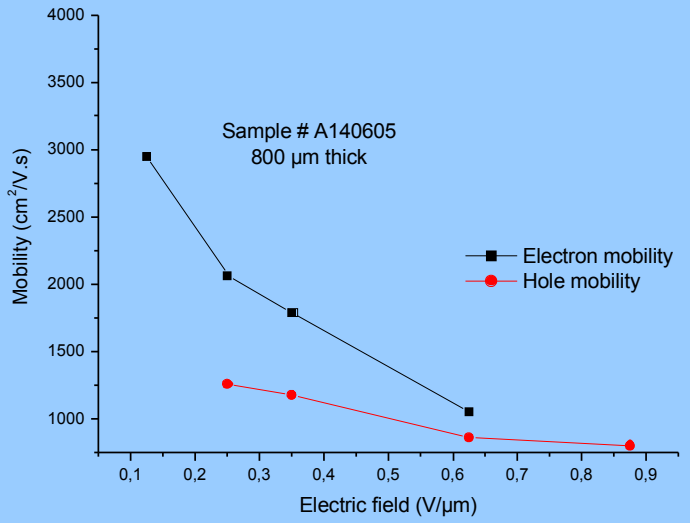
we have a content of about 10^{19} cm^3 C-H bounds in this sample !

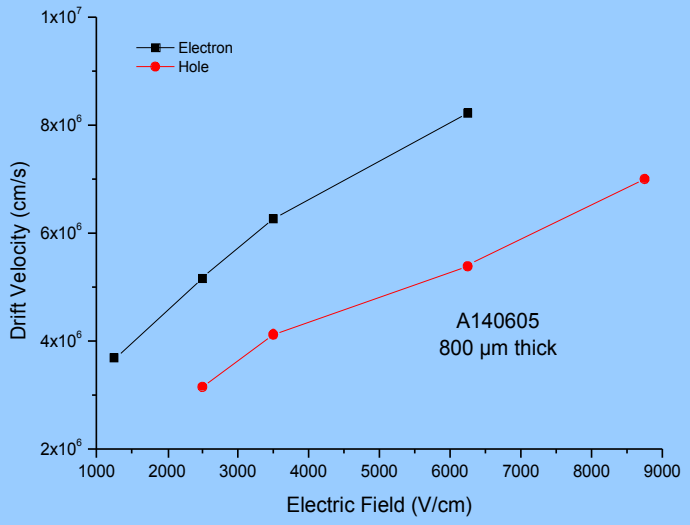
$$A = \alpha \times d$$

Acoustic phonons

Time Of Flight : ^{241}Am







$$v_{dr} = \frac{\mu_0 E}{1 + \frac{\mu_0 E}{v_s}}$$

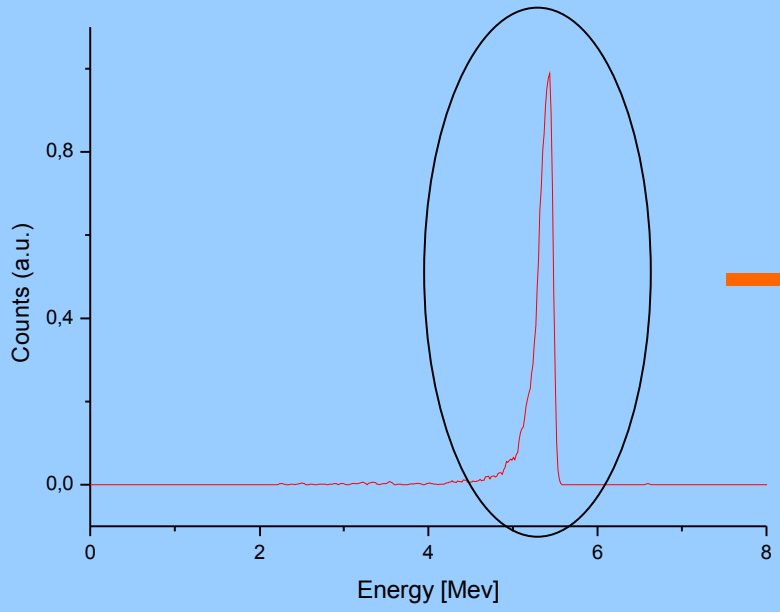
High mobility :

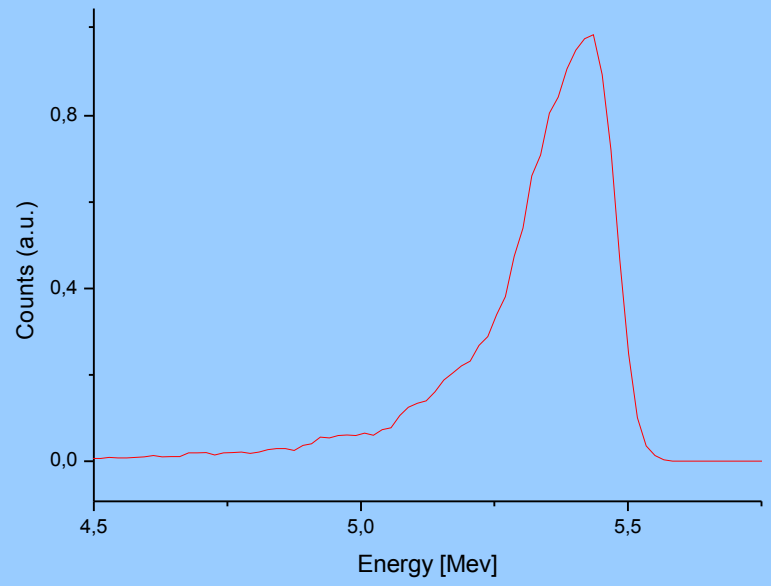
μ_e = 3838 cm²/V.S

μ_h = 1468 cm²/V.S

Reproducible measurements

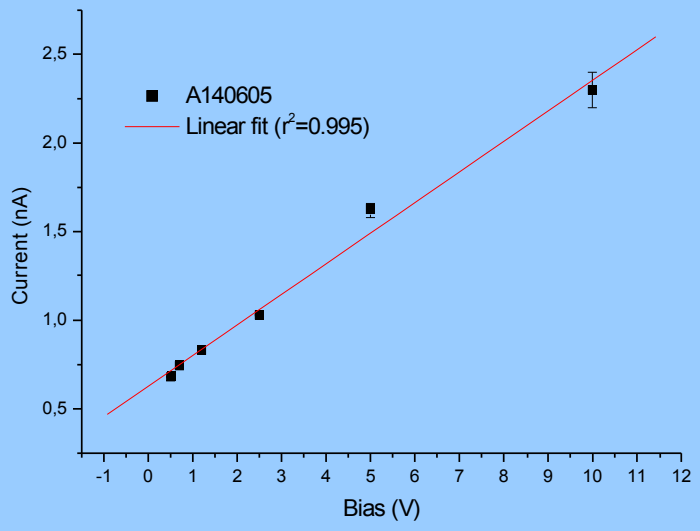
Current Charge Efficiency



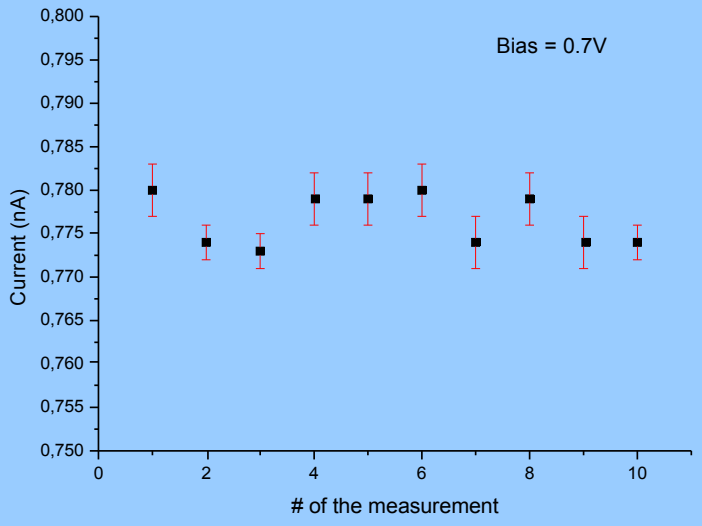


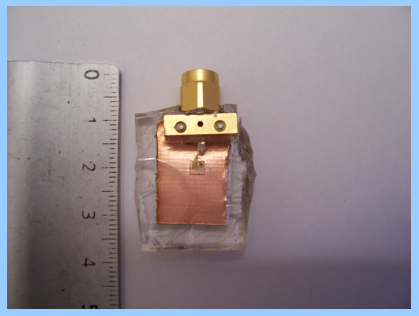
E = 0.4 V/μm
CCE = 98.6 %
∆E/E = 1.9 %

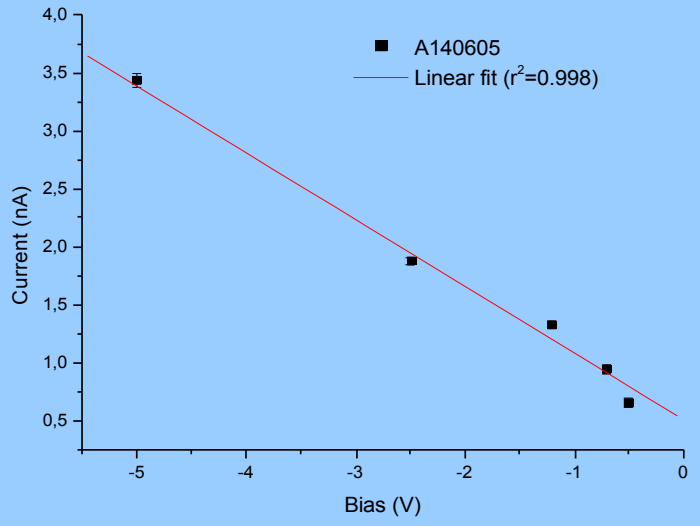
X-ray's measurement



Dose rate :
12 Gy/h







→ Linear response to the doses for both electrons and holes

→ Reproducible measurements

Perspective

- **Do FTPS measurements on our samples**
- **Design a new holder's shape**
- **Try other contacts on diamond**
- **Set up other growth conditions**

Thanks for your attention !!!