GRAPHENE AND 2DM VIRTUAL CONFERENCE & EXPO

10 ANNIVERSARY

Graphene online 2020 October 19-23

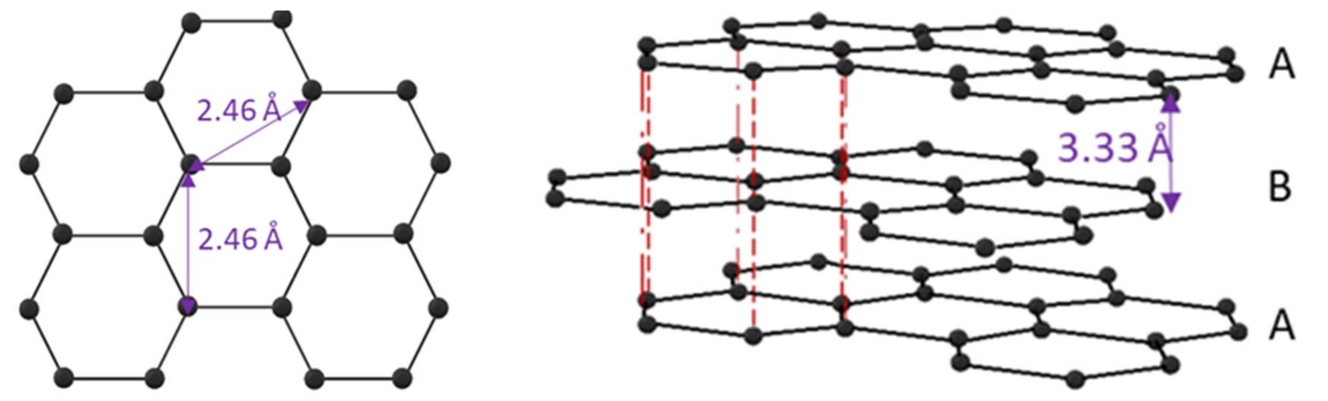
Two-steps CVD synthesis of Boron Nitride Islands on polycrystalline nickel substrate

Tailpied Laure(1), Andrieux-Ledier Amandine (2), Mérot Jean-Sébastien(1), Fossard Frédéric(1), Decams Jean-Manuel(3), Loiseau Annick(1)

(1) DMAS/LEM, (2) DPHY/CMT (3) Annealsys

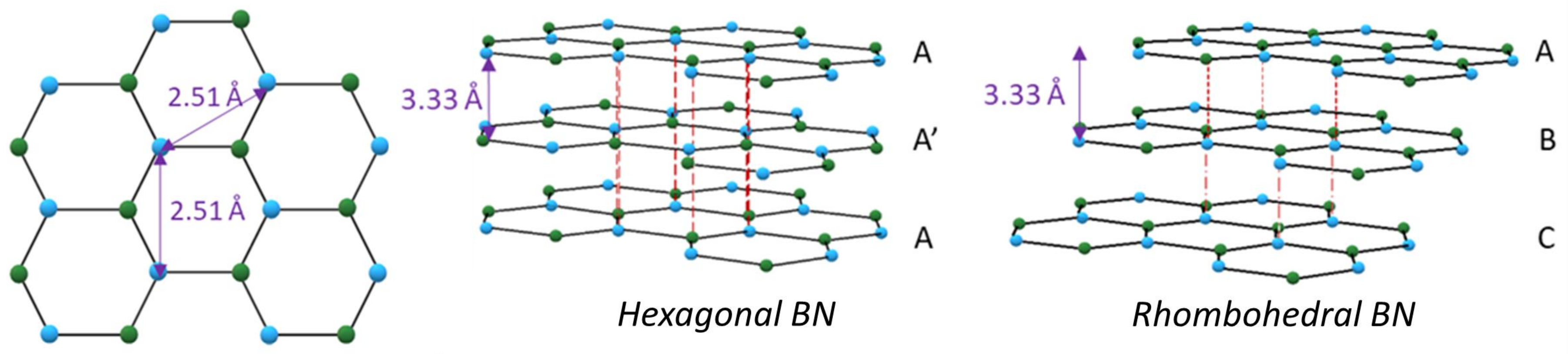
Graphene and sp²-hybridized boron nitride (BN) : unique and complementary 2D materials

Graphene



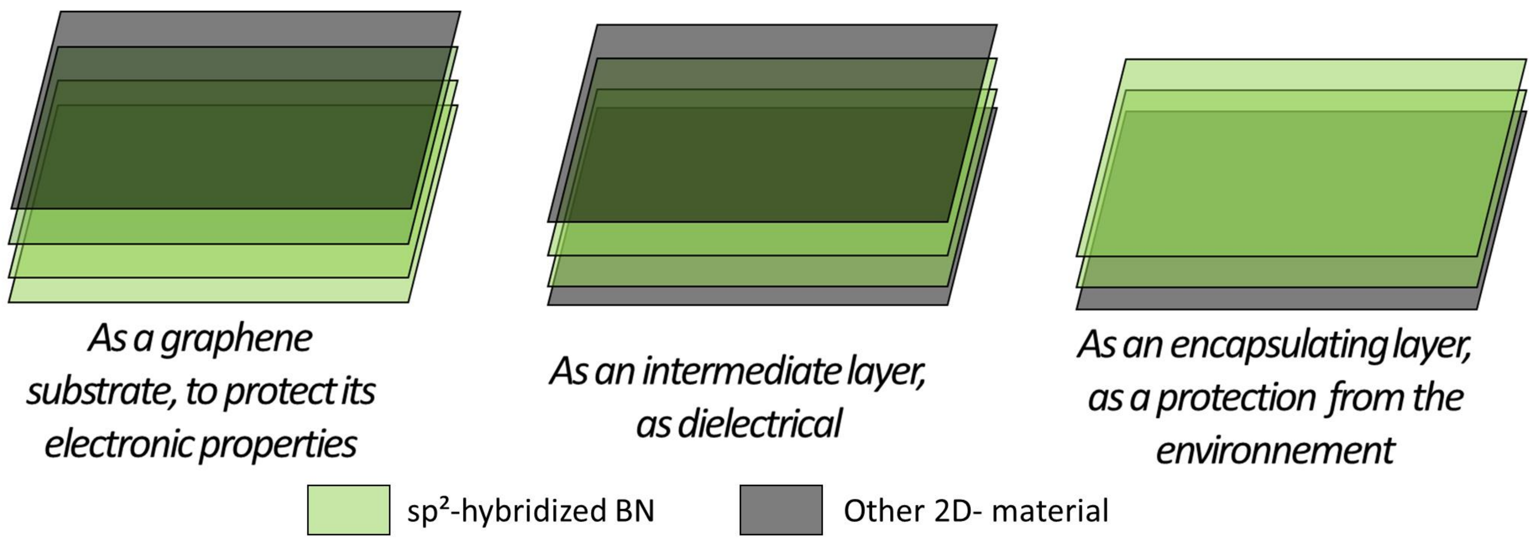
- ✓ Excellent conductor : $\mu_{Graphene}$= 200 000 $cm.V^{-1}.s^{-1}$ (102x $\mu_{Silicium}$)
- ✓ Record thermal conductivity : λ=5000 W/mK

sp²-hybridized BN

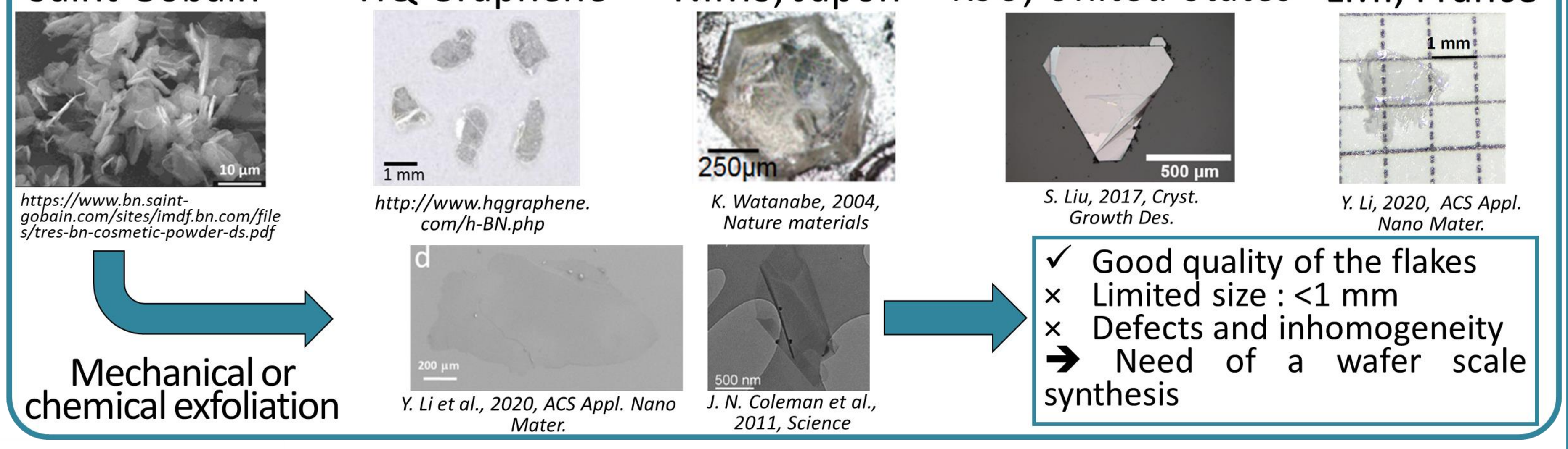


- ✓ High gap insulator (~6ev)
- ✓ Chemically and thermally stable

Role of BN in the Van der Waals heterostructures



Limitation: Few BN sources



- ✓ Good quality of the flakes
- × Limited size : <1 mm
- × Defects and inhomogeneity
- ➔ Need of a wafer scale synthesis

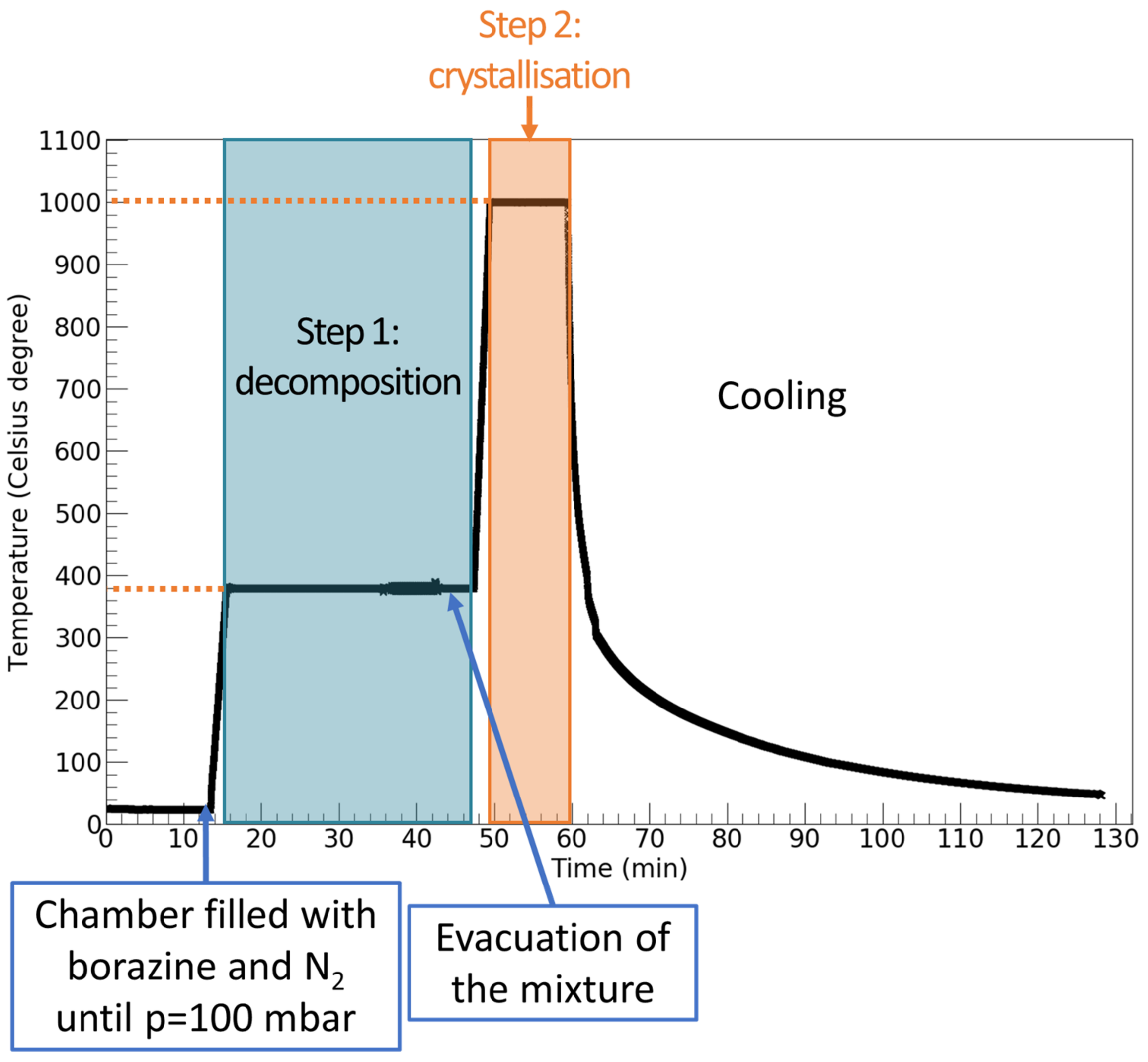
BN synthesis

Set up: Low pressure chemical vapor deposition (LPCVD)-AS ONE Annealsys

Substrate : polycrystalline Ni, 99.99%, thickness=25 μm

Precursor : Borazine ($B_3N_3H_6$)

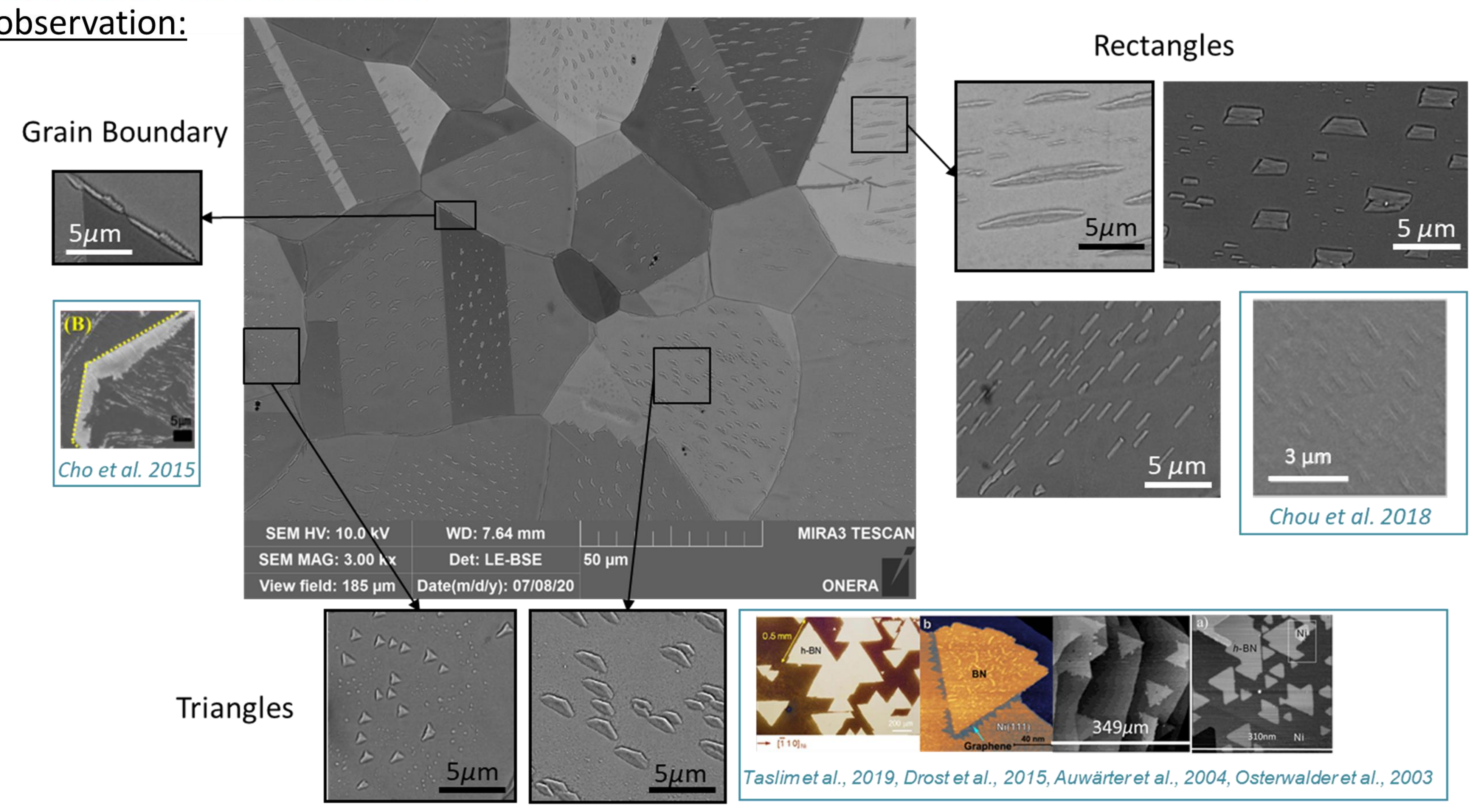
Process: Borazine reacts strongly under the halogens lamps used to heat the chamber ➔ two steps process used: Decomposition of the borazine at 380°C (Step 1) and crystalisation of the BN at 1000°C (Step 2) (*Y. Shi, 2010, Nanoletters*). The last step (step 3) is a fast cooling by extinction of the lamps under Ar/H_2.



Evolution of the temperature during a classical BN synthesis

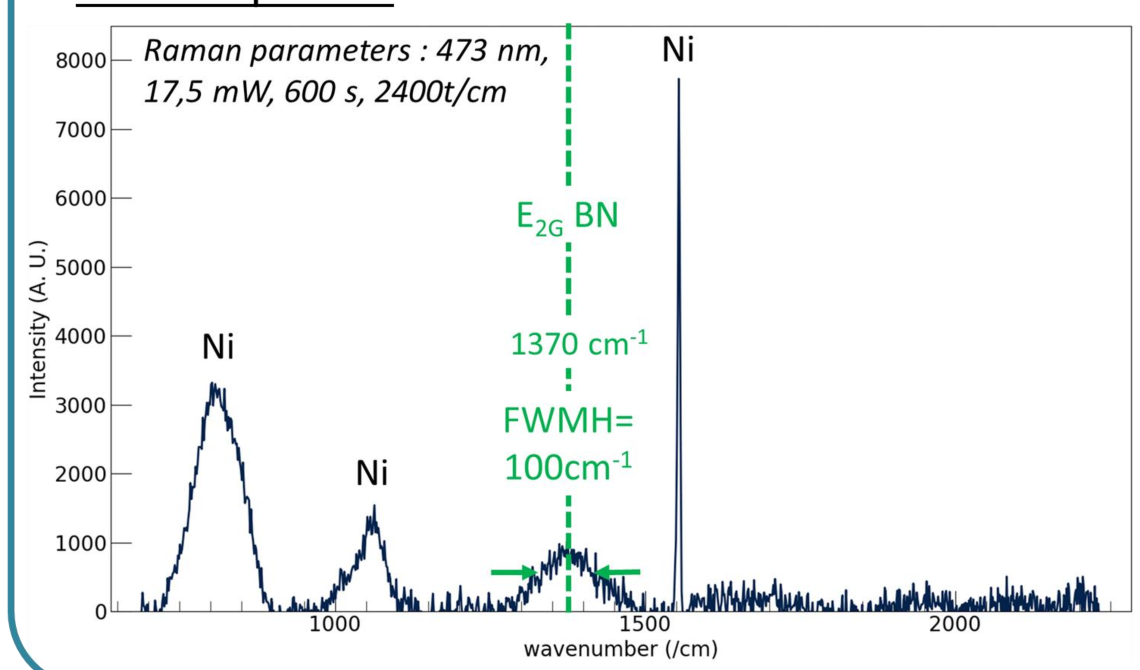
Results: BN islands

SEM observation:



BSE/SEM (backscattered electron scanning electron microscopy) images exhibiting crystallographic contrast of the Ni susbtrate and related BN deposit

Raman spectra:



- ✓ Micrometer sized BN islands with shapes consistent with the data of the litterature
- ✓ Islands shapes different for each underlying Ni grain orientation (*H. Prévost, 2020, 2D materials*)
- ○ Very broad peak in Raman spectroscopy ➔ Low crystallinity ?

Conclusion & Perspectives

- ✓ BN islands are obtained from borazine with a two-steps process. Their size and shape change as a function of the orientation of the underlying Ni grain
- ❑ To obtain a better crystallinity of the BN, the duration of the crystallization step will be extended
- ❑ Other parameters, such as the temperature of the decomposition step and the cooling speed will be modified to obtain a BN continuous film

Acknowledgement

- The research leading to these results has received partial funding from the European Union's Horizon 2020 research and innovation program under grant agreement N° 881603 (Graphene Core 3) , ONERA and GDR-I Graphene&Co (for the subscription fees). Authors want to thanks the Annealsys society for the research collaboration. This work has benefited from SEM facilities and staff expertise of Laboratoire Castaing (DMAS/ONERA)

CONTACT PERSON

Laure Tailpied
laure.tailpied-ext@onera.fr
PHD student at Laboratoire d'Etude des Microstructures (LEM)
UMR 104 Onera-Cnrs

REFERENCES

https://www.bn.saint-gobain.com/sites/imdf.bn.com/files/tres-bn-cosmetic-powder-ds.pdf
http://www.hqgraphene.com/h-BN.php
K. Watanabe et al., 2004, Nature materials
S. Liu et al., 2017, Cryst. Growth Des.
Y. Li et al., 2020, ACS Appl. Nano Mater.
J. N. Coleman et al., 2011, Science
A. Taslim et al., 2019, Nanoscale
H. Cho et al., 2015, Sci. Rep.
H. Chou et al. 2018, ACS Appl. Mater. Inter.
R. Drost et al., 2015, Sci. Rep.
W. Auwärter et al., 2004, Chem. Mater.
J. Osterwalder et al., 2003, e-J. Surf. Sci. Nanotech.
Y. Shi et al. 2010, Nano Lett.
H. Prévost et al. 2020, 2D Mater.

Graphene online 2020