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Fundamental Research Insights

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Graphene and Boron-doped Graphene by Pulsed Laser Deposition

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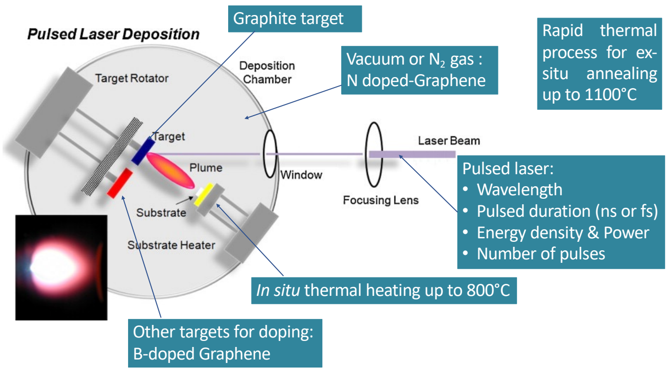
1. Graphene synthesis from Pulsed Laser Deposition



Very few study on graphene synthesis using PVD process.

PVD advantages are:

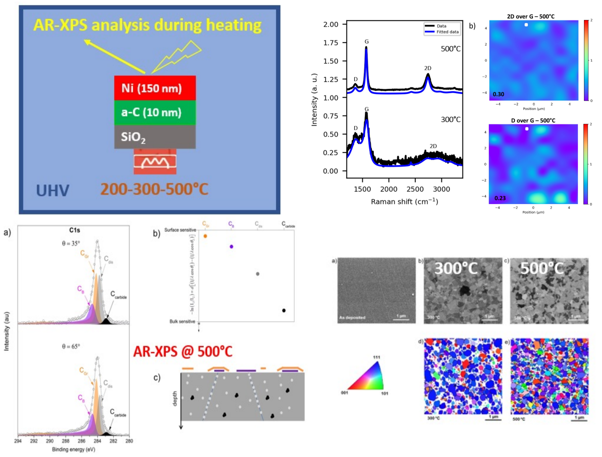
- Thickness control of carbon/metal coatings.
- Doping (B, N…) control in the carbon coating.
- Lower Temperature (vs CVD).

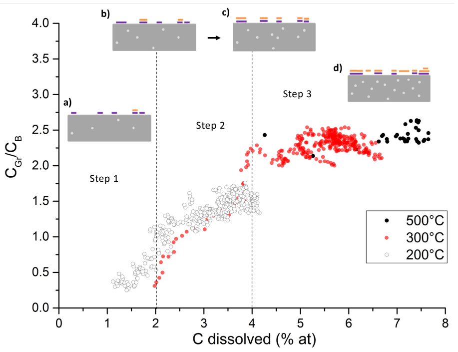
PLD as a PVD Versatile Process for graphene growth:

- Control of Doping (B, N…) at all concentrations, by reactive PLD or co-PLD.
- Interest of thermal heating in situ during PLD.

Review: Bleu et al, Frontier in Chemistry, 2018

2. Growth mechanism of Graphene from *in situ* XPS during thermal heating

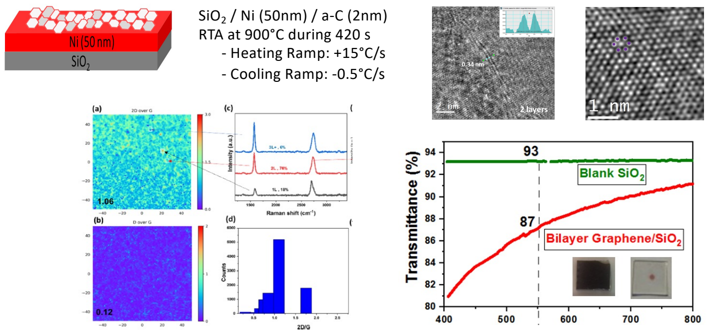




A three-step process, depending on the dissolved carbon concentration in Ni:

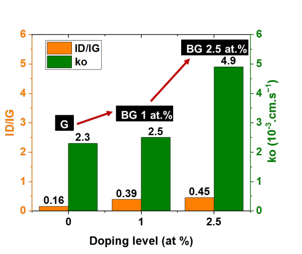
- Step 1: Islands of monolayer epitaxial graphene; $C_{diss} < 2$ at.%
- Step 2: Additional dissolved C promotes progressive growth of bilayer
- Step 3: Formation of weakly interacting few-layer graphene, $C_{diss} > 4$ at.%

3. Transfer-free undoped graphene via PLD and RTP

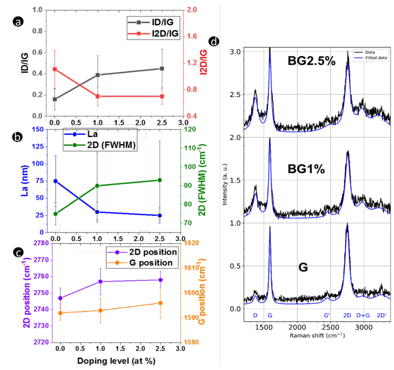


- Dominant bilayer graphene with few defects at 900°C
- Graphene domains of 130 nm deduced from D/G
- Transmittance of 87% @ 550 nm, corresponding to 2 layers on SiO_2.

4. B-G produced by PLD for the first time



Samples	ΔE (V)	Ko (10^{-3} cm.s^{-1})
G	0.35	2.3
BG 1	0.17	2.5
BG 2.5	0.20	4.9



- Boron doping increases defect level and affects the graphene layer formation.
- Upshifts of G and 2D peaks with the boron doping.
- Higher electrochemical reversibility ΔE of graphene with B incorporation
- Higher kinetic electronic transfer compared to the undoped graphene
- The electron transfer capability k_0 is dependent on the boron concentration

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