Synthesis of Graphene and its potential application in SERS for glucose detection

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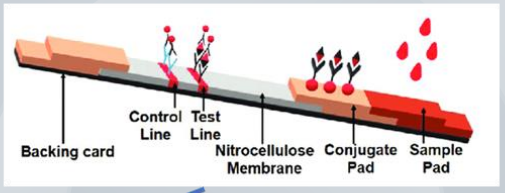
Introduction

- Glucose is the main source of fuel for the brain and Cells uses glucose for energy, however when in access, it can cause life-threatening complications such as diabetes, kidney failure, cardiovascular diseases, and nerve damage.
- Several techniques have been developed to detect and diagnose glucose

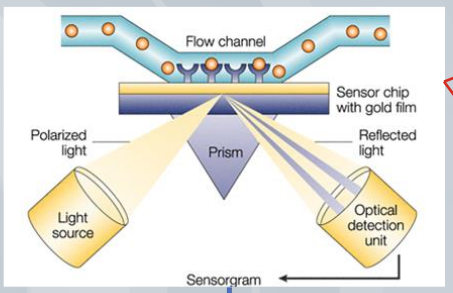
1. Electrochemical Biosensors

- Invasive = Nerve endings damage
- Uncomfortable for patient
- Infection risk from bruised skin

2. Lateral Flow Assay

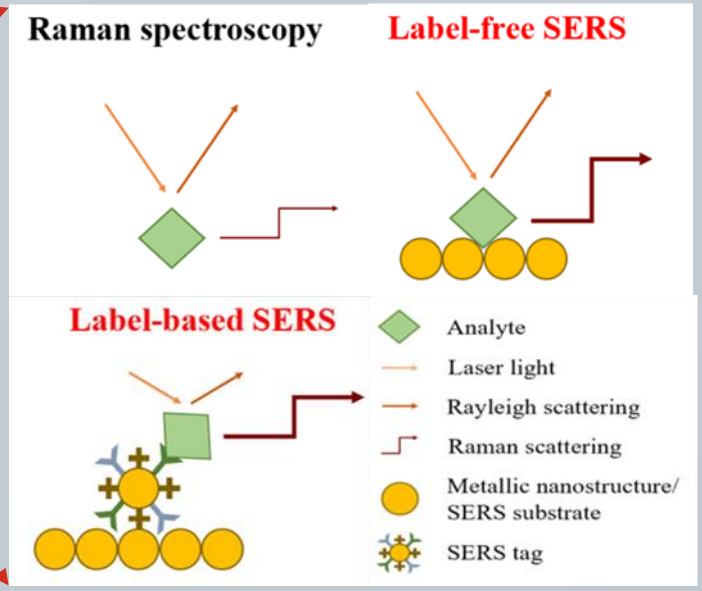


3. Optical Biosensor



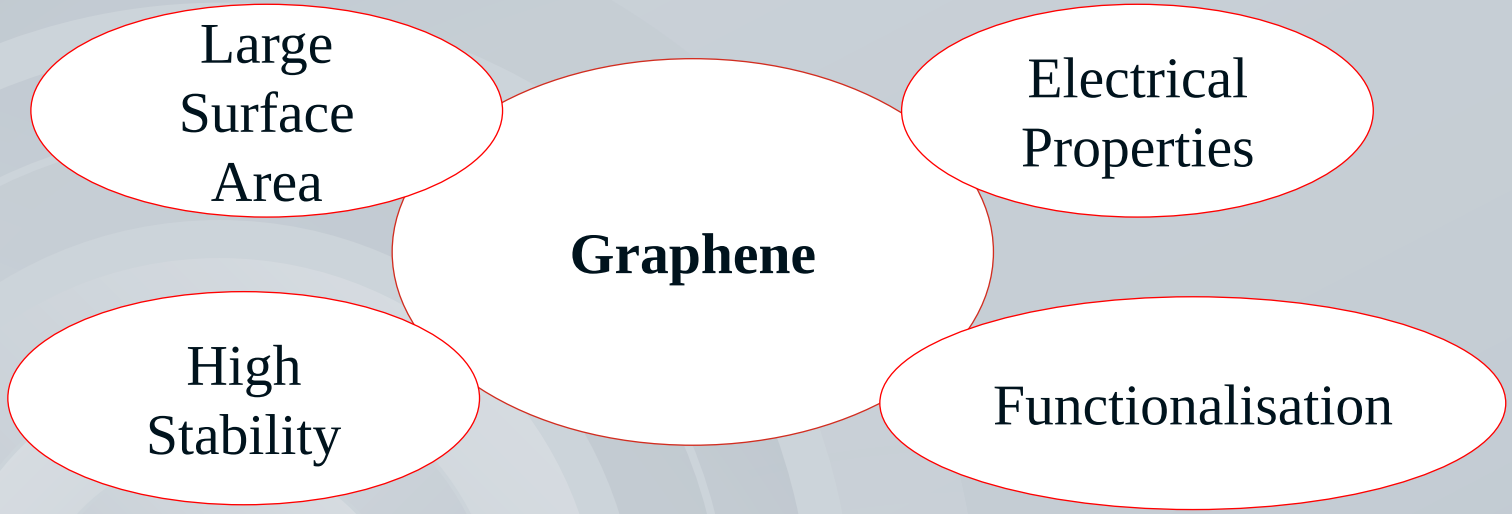
- Non-Invasive
- Simple sample collection
- Safer for both children and adults

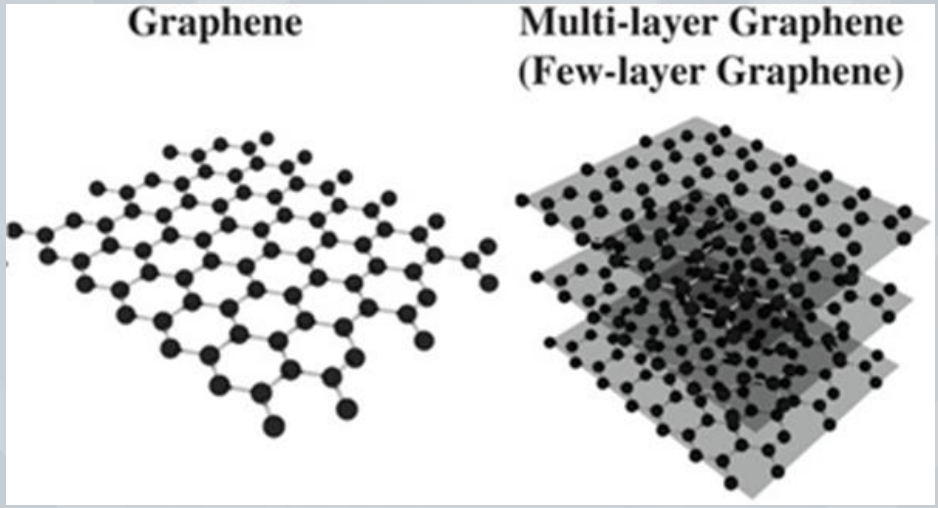
Surface enhance Raman spectroscopy (SERS)

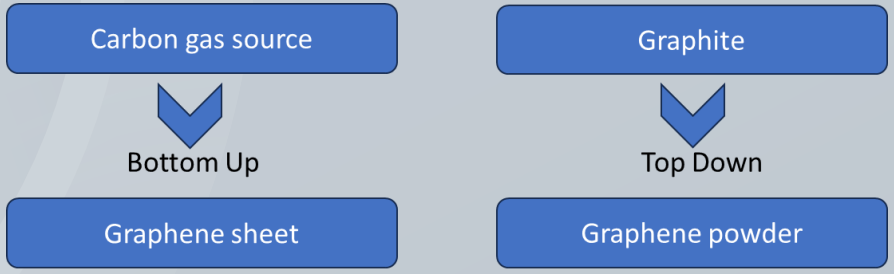


- SERS requires the use of a substrate in order to enhance the signal particles such as Au, Ag, Cu nanoparticles.
- This study proposes 2D carbon nanomaterial , specifically graphene.

Graphene


Large Surface Area
Electrical Properties
Graphene
High Stability
Functionalisation


Graphene
Multi-layer Graphene
(Few-layer Graphene)


Carbon gas source
Bottom Up
Graphene sheet
Graphite
Top Down
Graphene powder

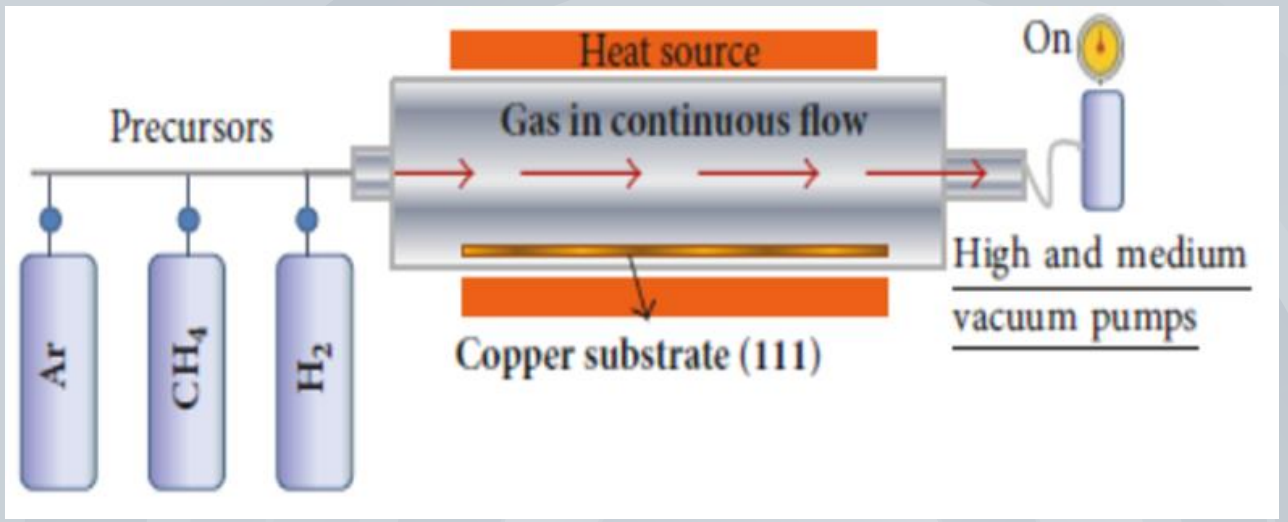
Introduction Cont'd

Synthesis Methods		
	Advantages	**Disadvantages**
Mechanical Exfoliation	Simple process High quality	Produces only few micron sheets Limited applications Time consuming Low reproducibility Unscalable
Chemical methods	Disperse easily in different mediums Easy surface functionalisation	Significant structural damages Poor electrical properties Limited applications
Epitaxial growth	High quality Highly applicable in electronics	Requires High temperatures (>1300°C) High energy High substrate cost Hard to transfer Requires vacuum
Chemical Vapour Deposition (CVD)	High quality Controllable number of layers Can produce large area graphene Scalability Low-cost substrate Reproducibility	High temperatures (±1000°C) Graphene transfer (induce defects)

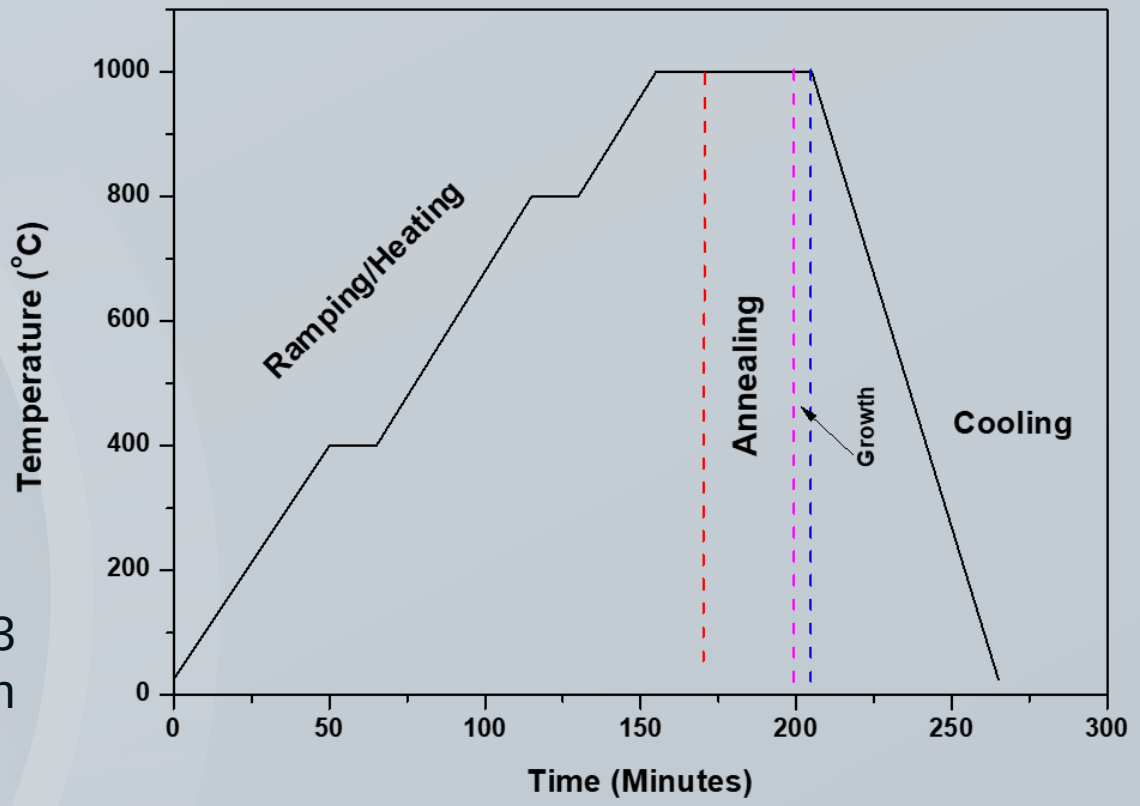
Aim

Synthesise graphene with controllable number of layers and varying quality

a)



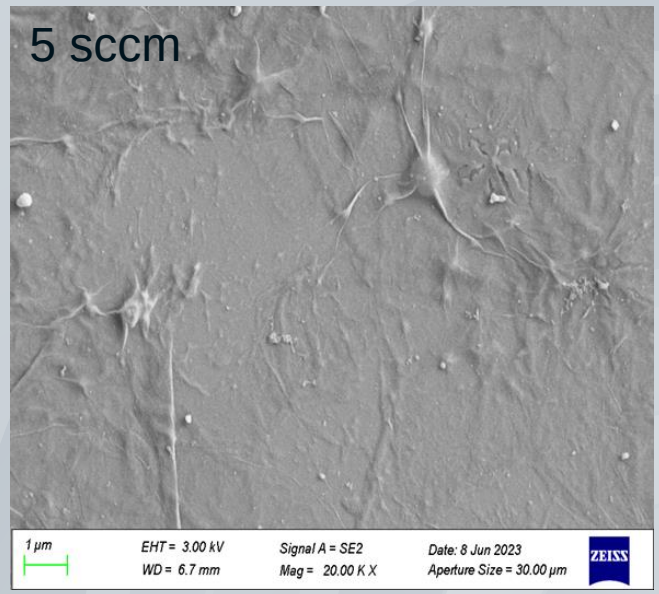
b)

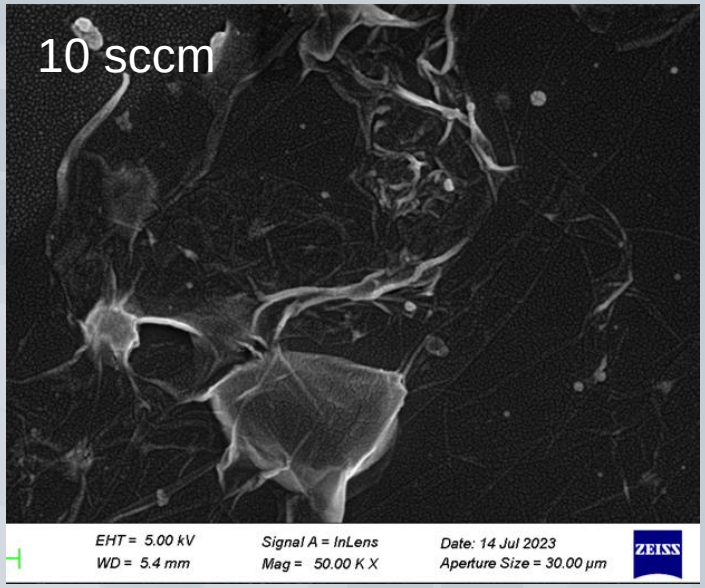


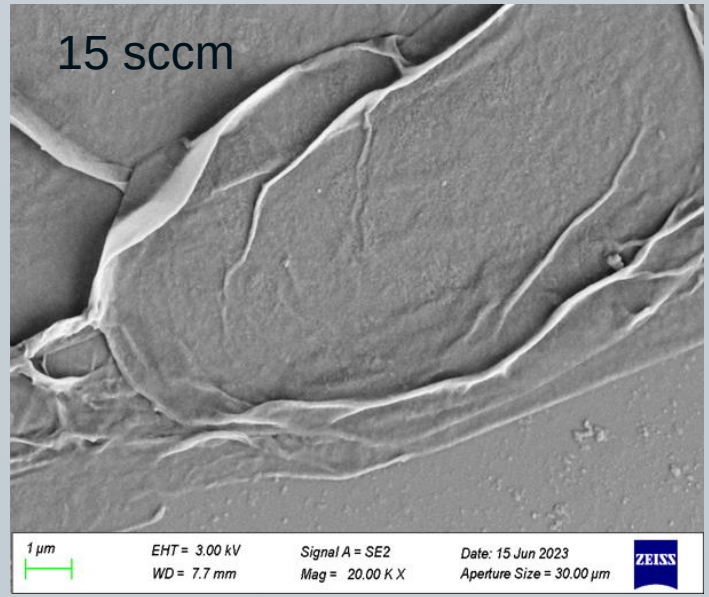
- Typical CVD technique for graphene synthesis involves 3 gases, namely, carbon source gas such as CH_4, Hydrogen and Argon.

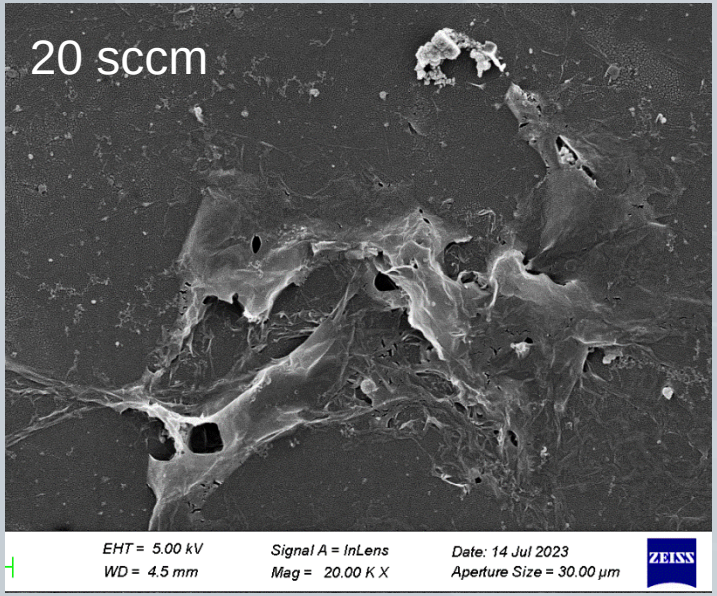
Figure 1: a)schematic diagram of CVD and b) the temperature profile of CVD process

Results and discussion









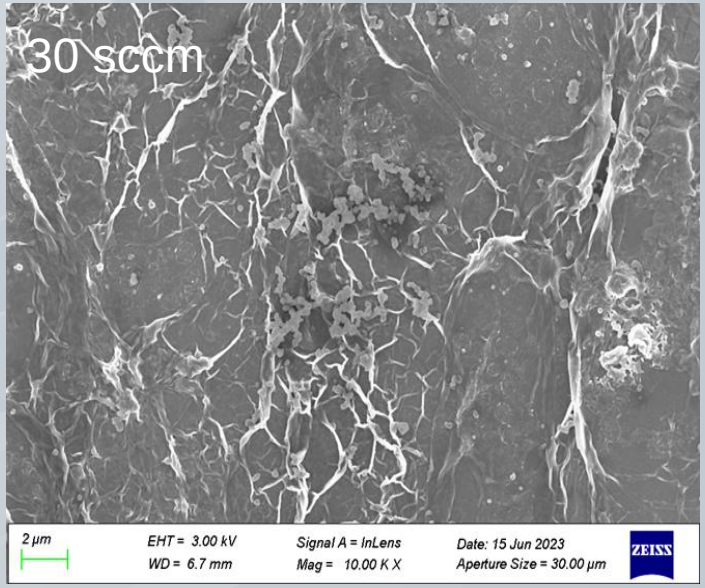
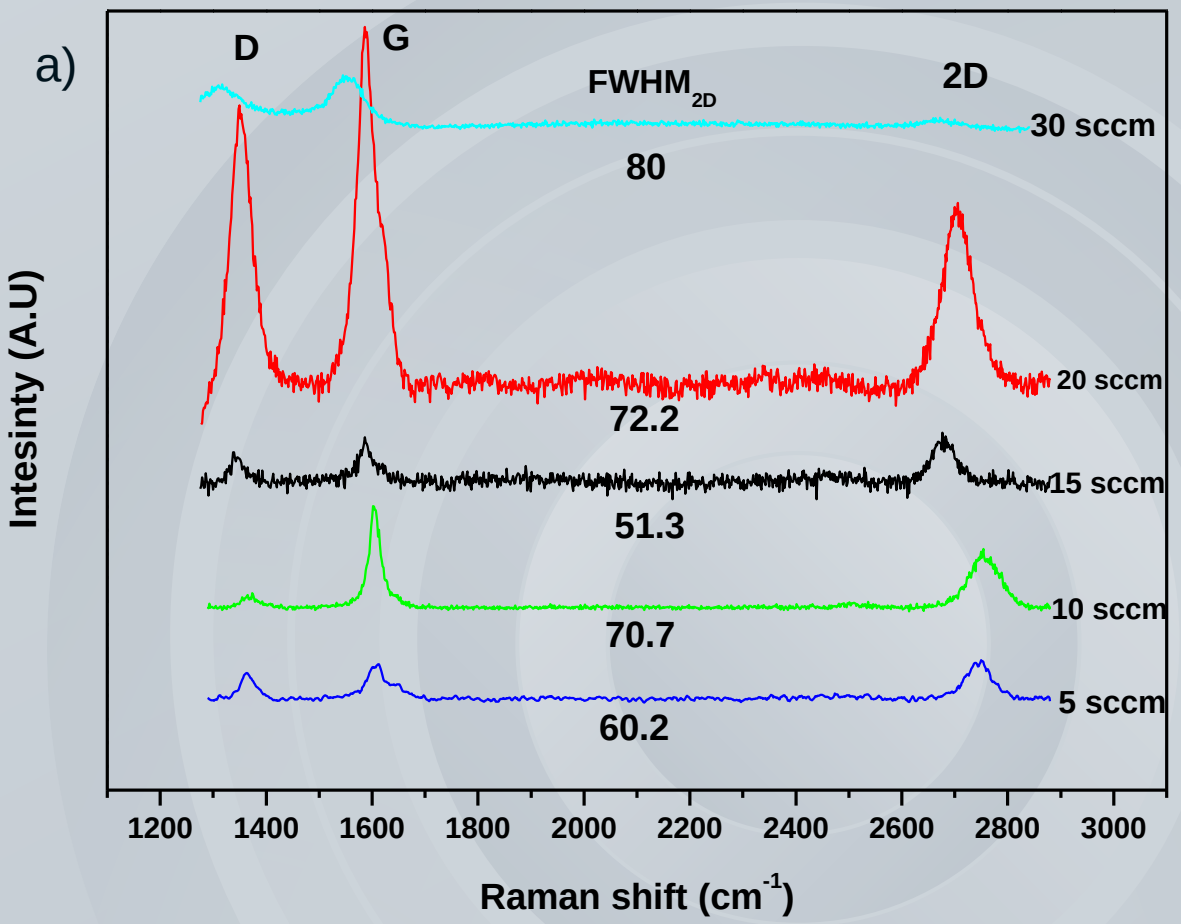


Figure 2: SEM images of materials synthesised at different flowrates for 10 minutes



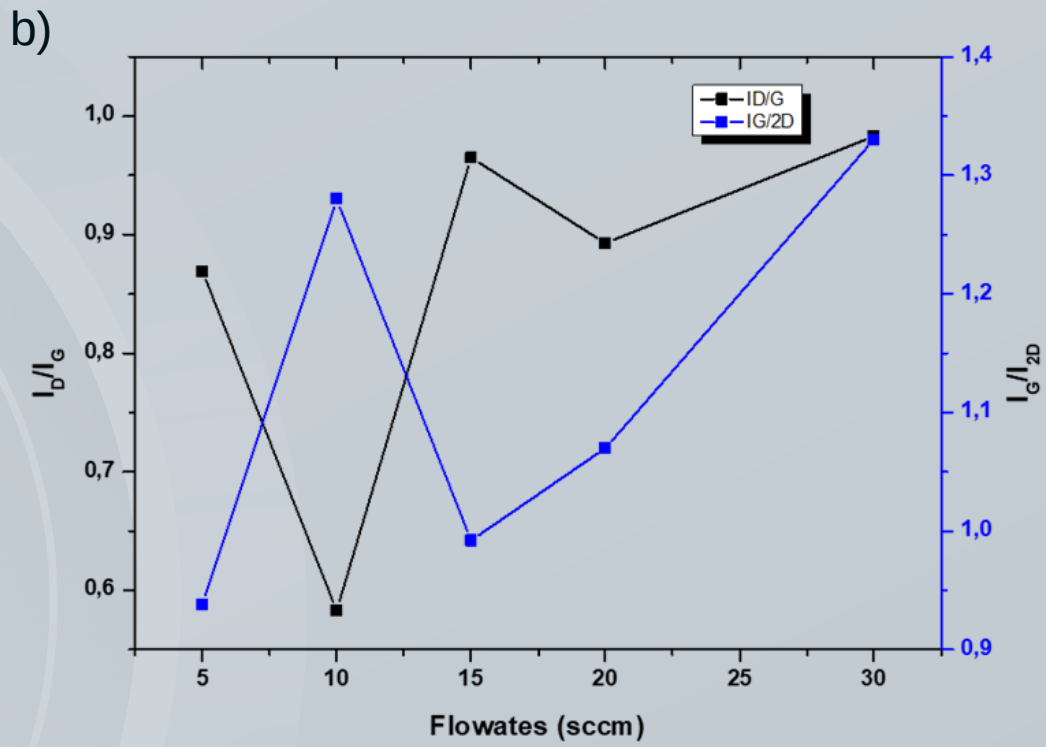
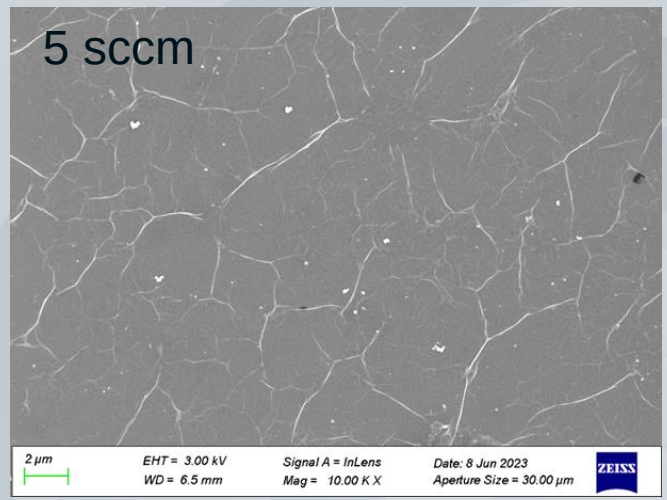
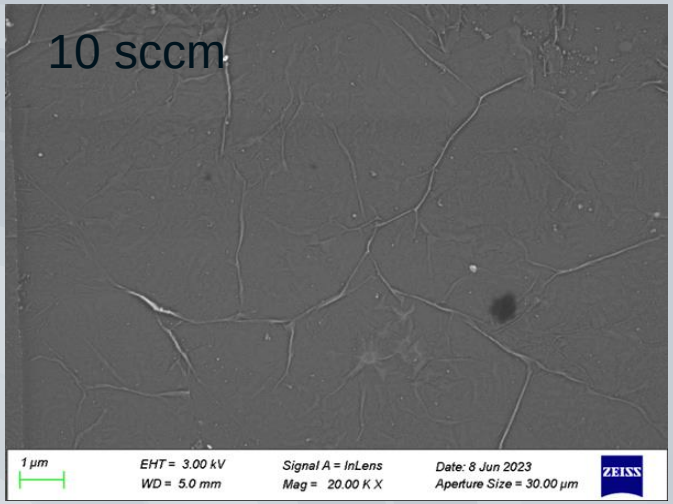
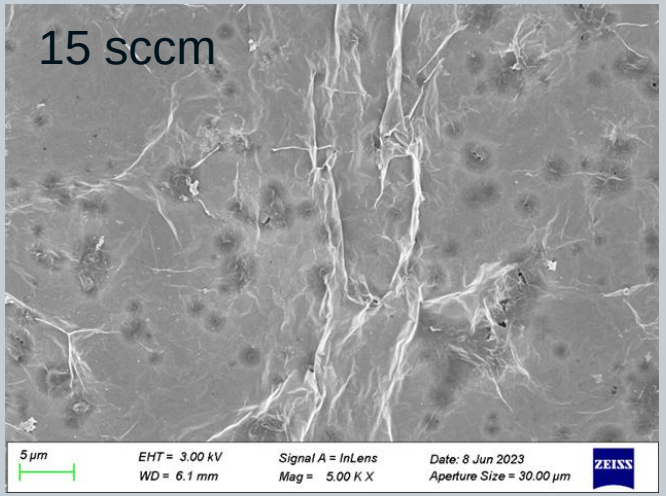
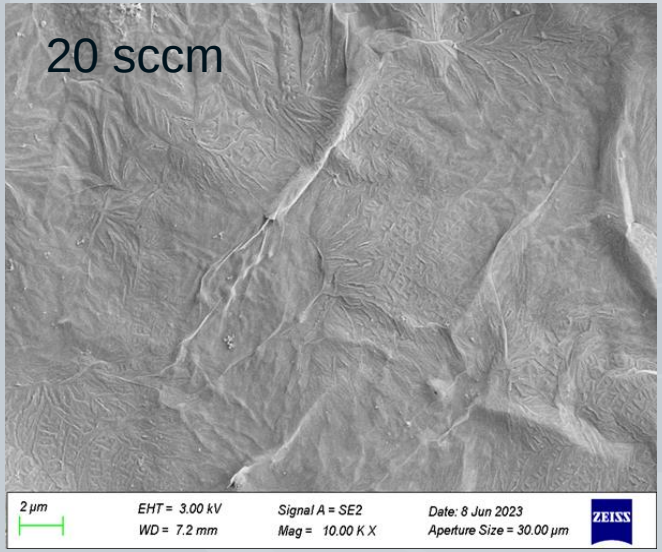


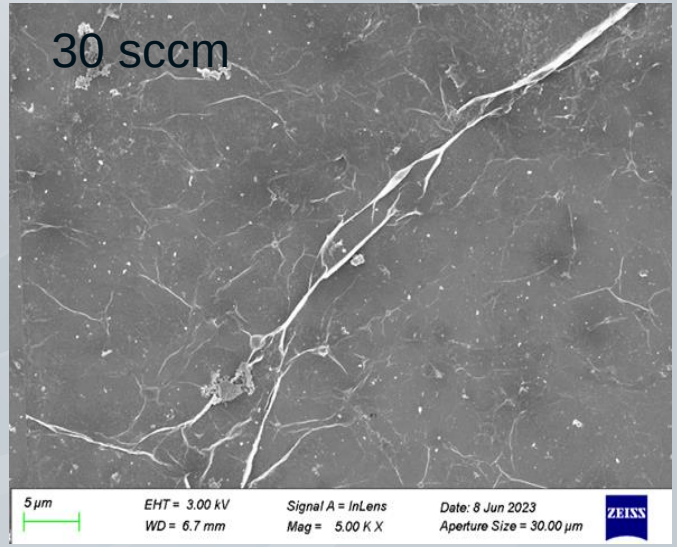
Figure 3: a) Raman spectra of graphene synthesised for 10 minutes at different flowrates, and b) D,G and 2D ratios at different flowrates.











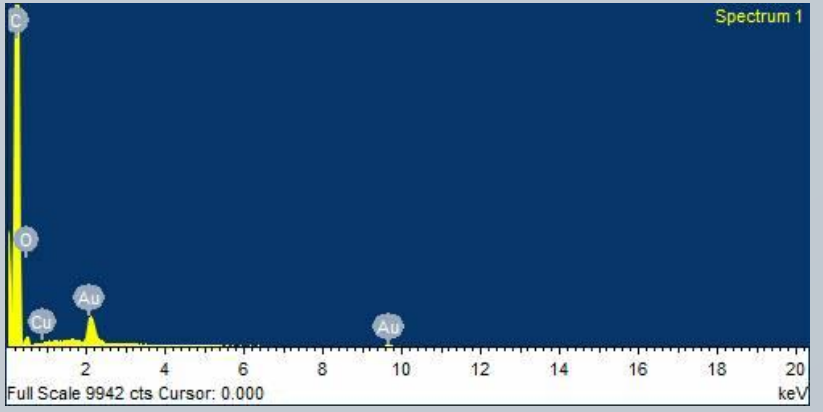


Figure 4: SEM images of materials synthesised at different flowrates for 20 minutes

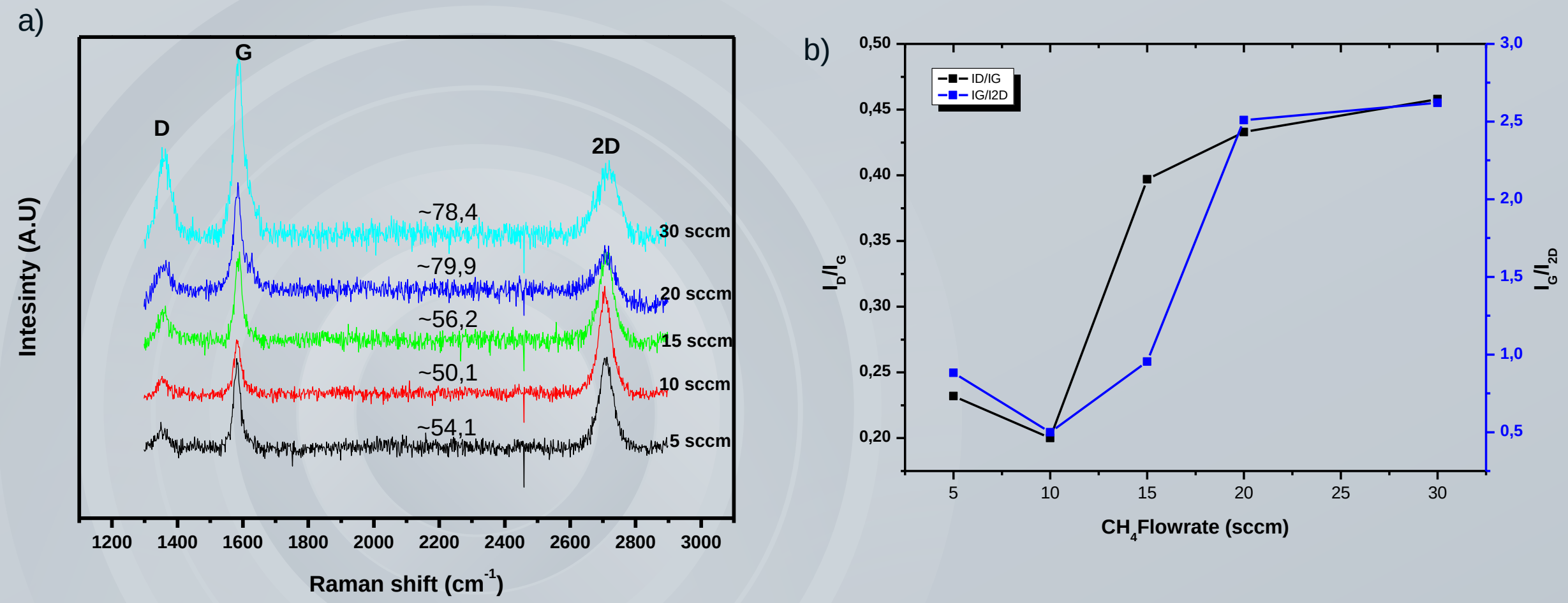
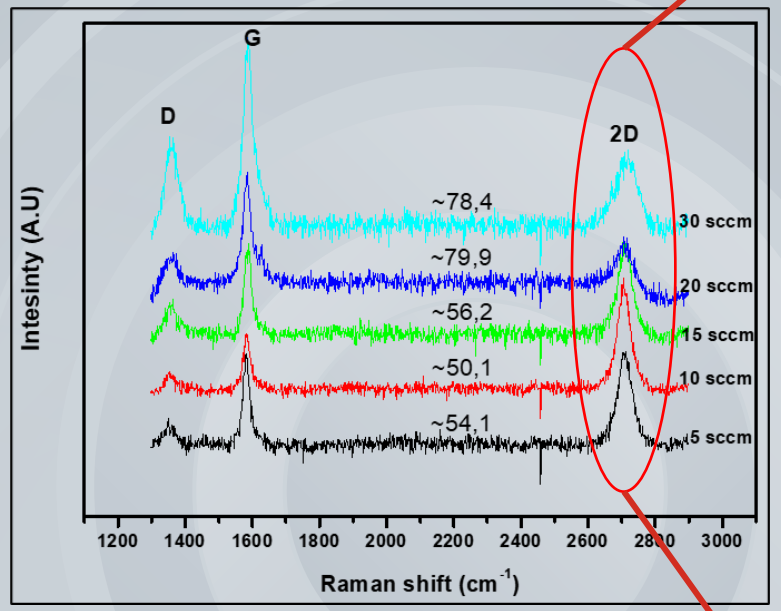


Figure 5: a) Raman spectra of graphene synthesised for 20 minutes at different flowrates, and b) D,G and 2D ratios at different flowrates.

Results and discussion cont'd



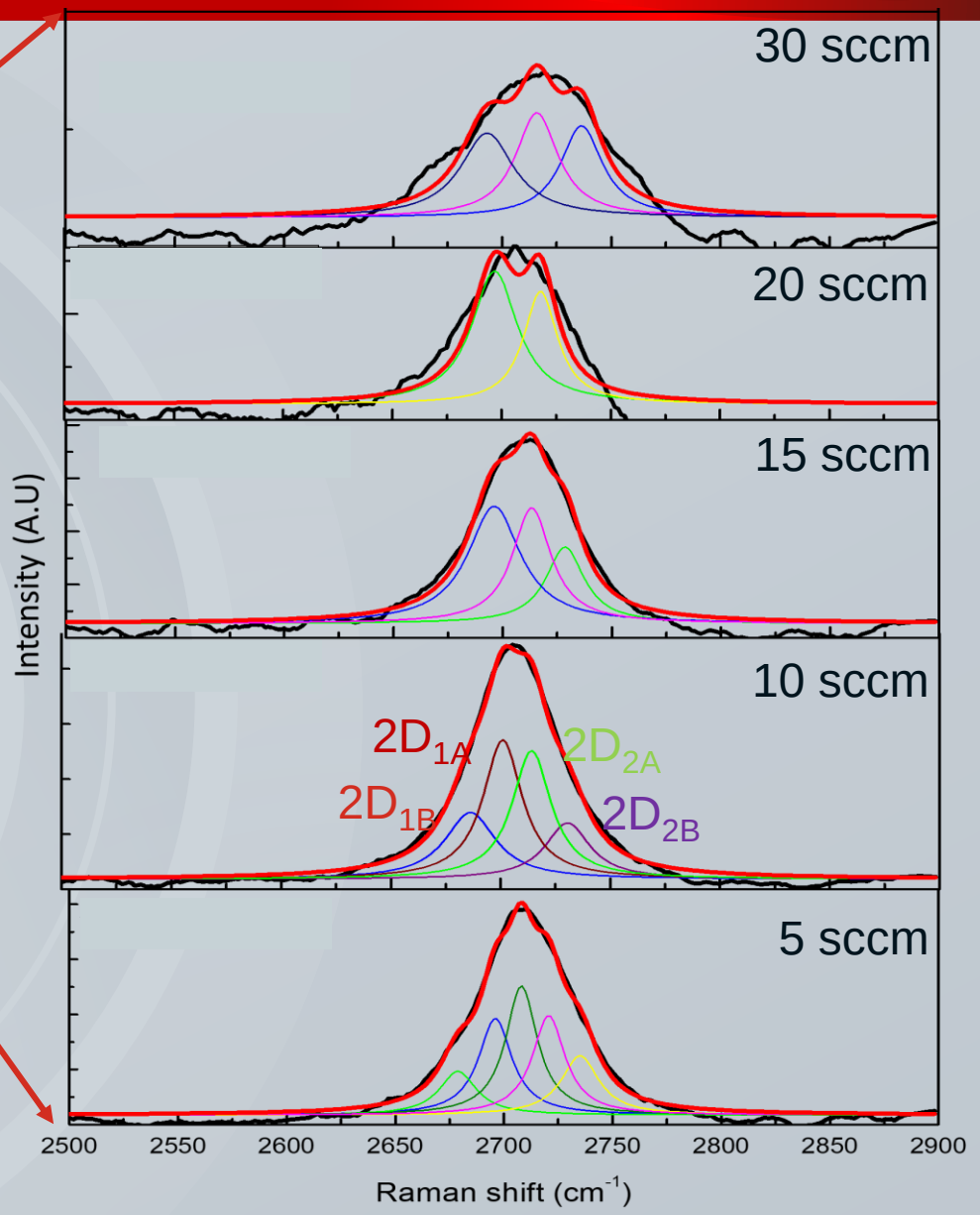


Figure 6: Deconvolution of the 2D bands of graphene synthesised for 20 minutes

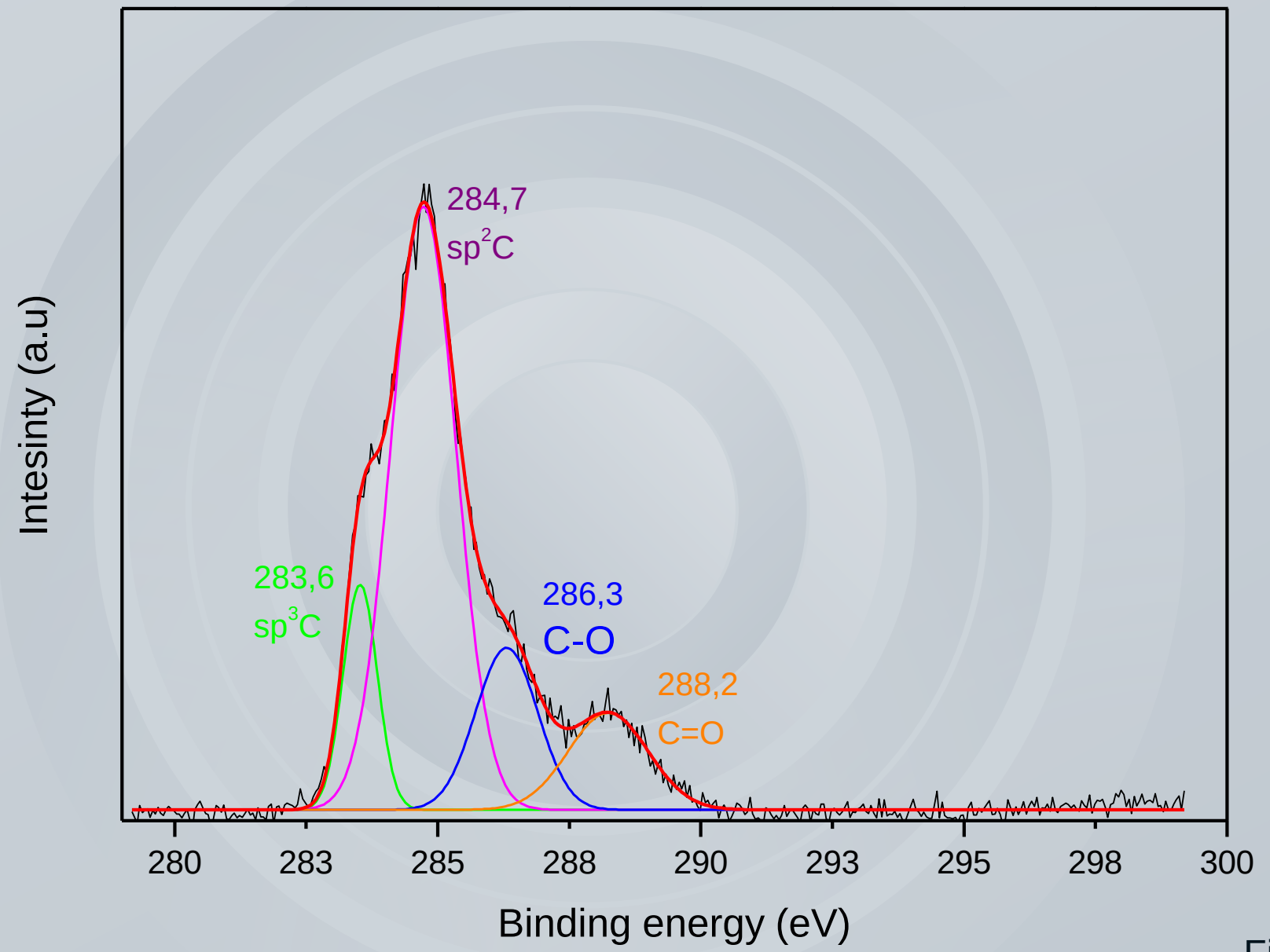


Figure 7: XPS C1s spectrum of graphene

Conclusion

- Different flowrates and reaction times were investigated yielding different quality of graphene
- Bi-layer to multilayer graphene was successfully synthesised.

Ongoing work

- Testing graphene as a surface enhanced graphene spectroscopy (SERS) substrate

Acknowledgements

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Thank You

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