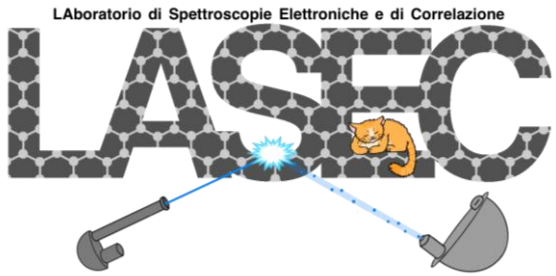
Punto della situazione sulla idrogenazione del grafene

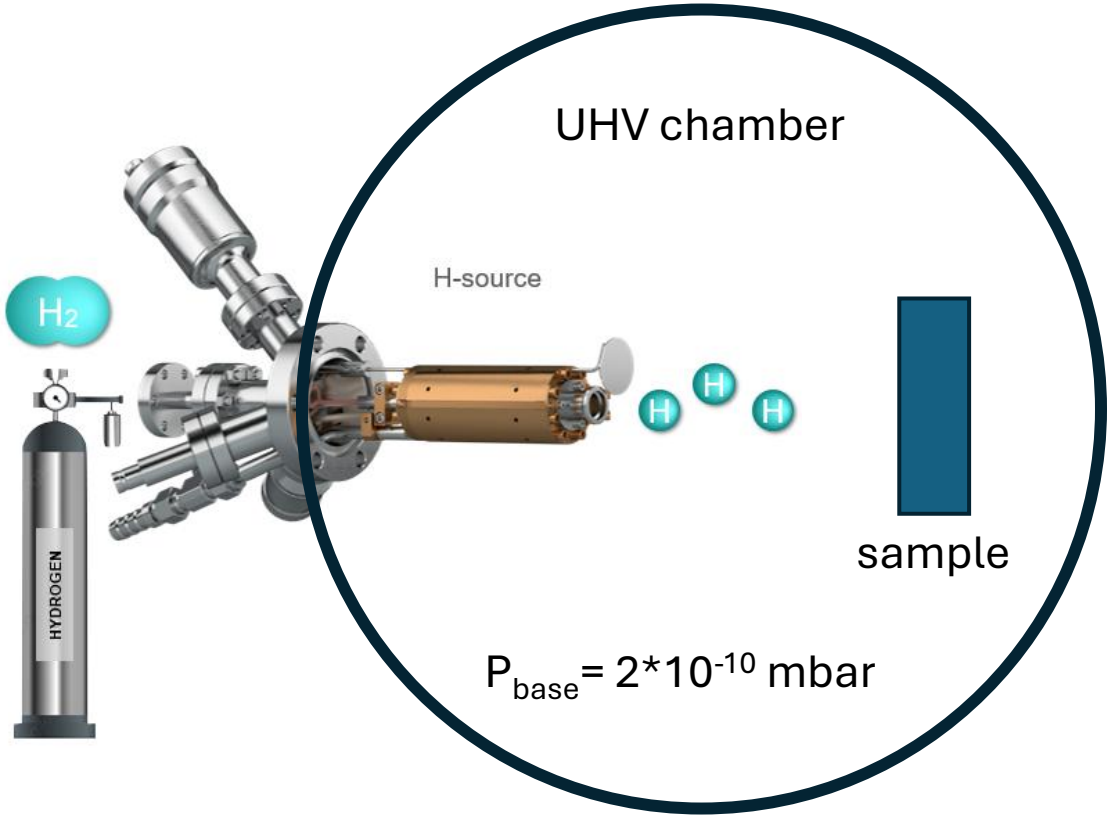
Alessandro Ruocco

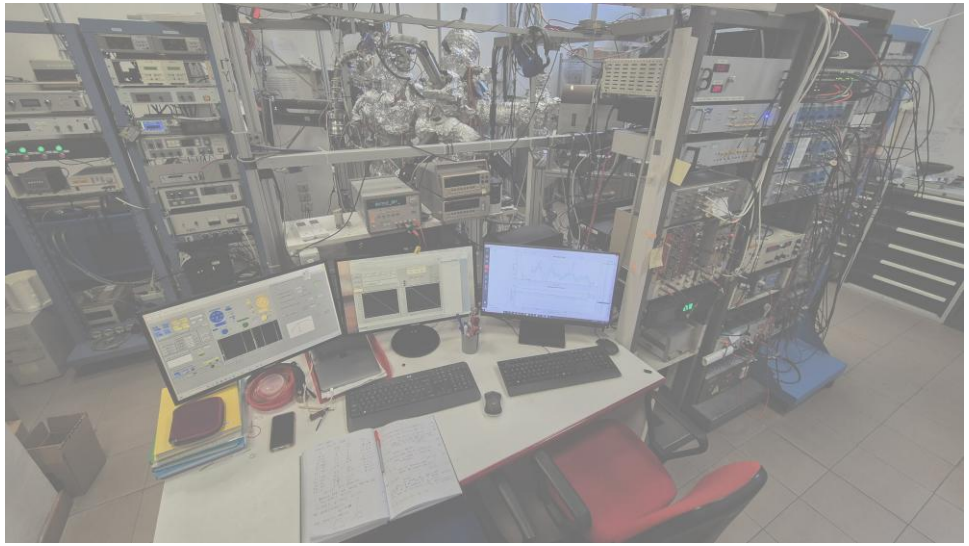
Università e INFN Roma TRE

Ptolemy incontro con i referee 25.07.25



Come idrogeniamo il campione



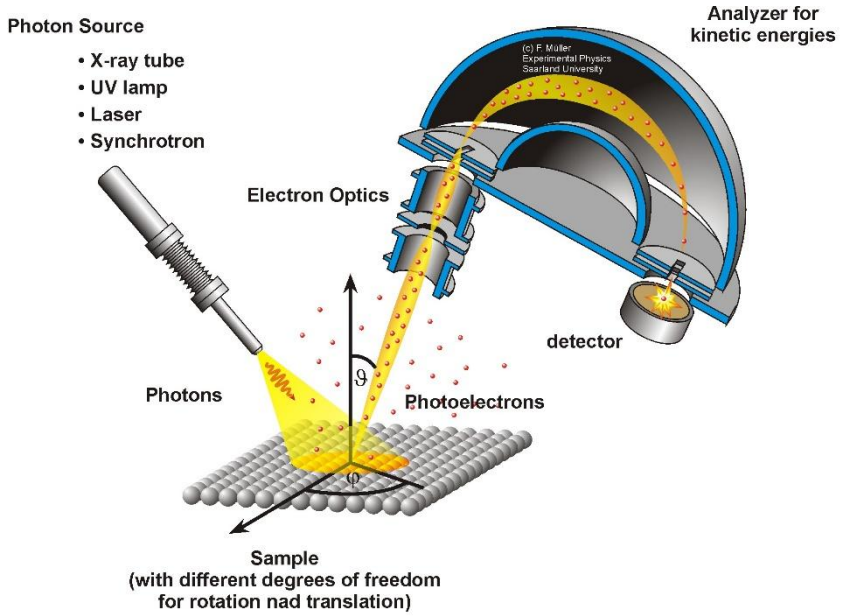


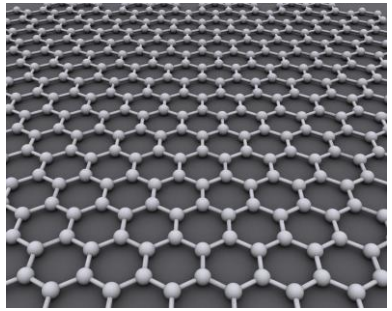
LAboratorio di Spettroscopie Elettroniche e di Correlazione

LASEC

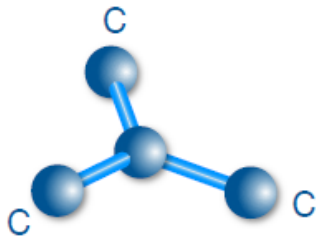
Come determiniamo l'uptake di idrogeno

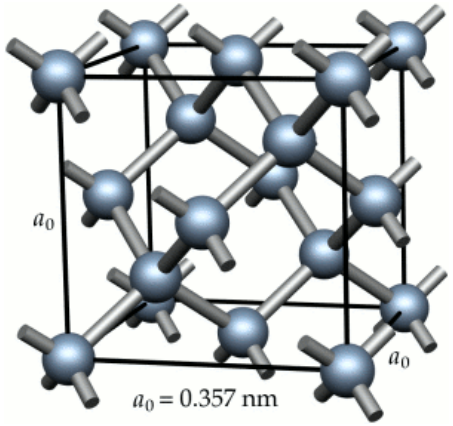
Fotoemissione dai livelli di core (XPS)



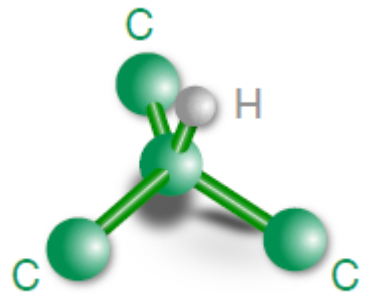


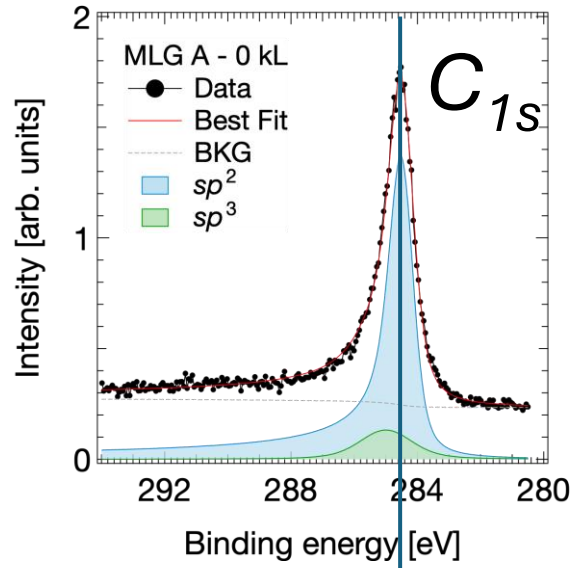
sp^2

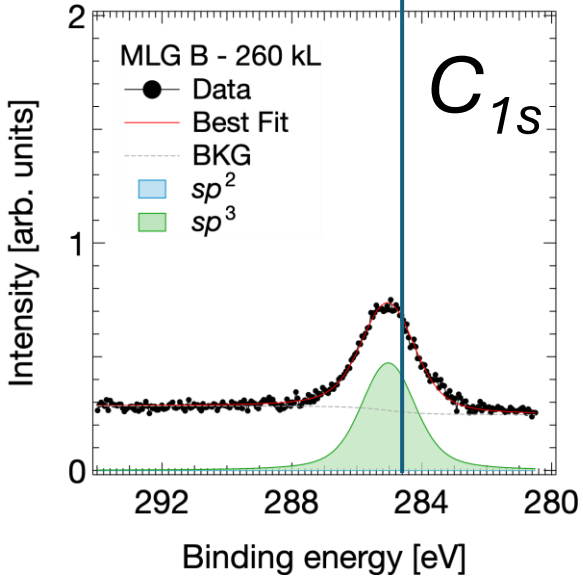




sp^3







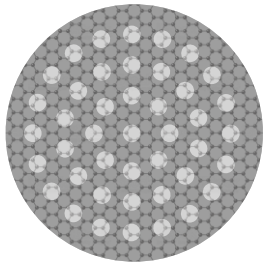
A. Apponi et. al Carbon 216 (2024) 118502,
B. DOI:10.1016/j.carbon.2023.118502

Idrogenazione di nanostrutture a base carbonio

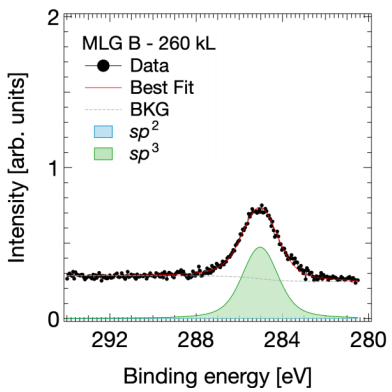
Materiali

Idrogenazione

Graphene on TEM grid



2 mm

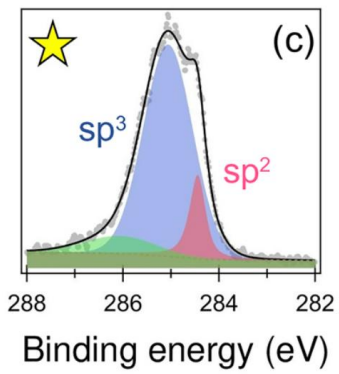


Apponi et al. In preparation

✤ $sp^3/(sp^2+sp^3) \approx 100\%$

Nano Porous Graphene (NPG)

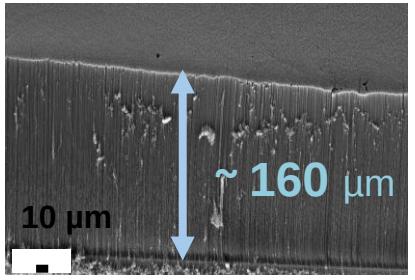
5 mm



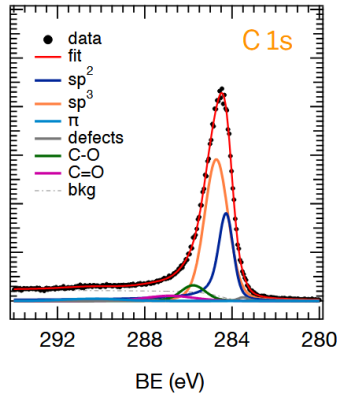
Betti, M.G. *et al.*, *Nano Letters* (2022), 10.1021/acs.nanolett.2c00162

✤ $sp^3/(sp^2+sp^3) \approx 90\%$

Carbon Nano Tube (CNT)

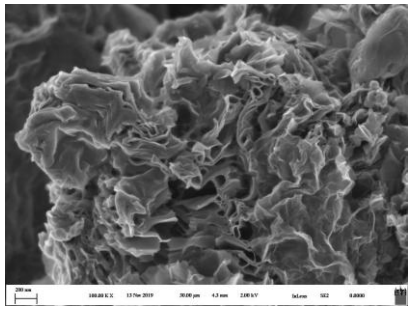


10 mm



✤ $sp^3/(sp^2+sp^3) \approx 67\%$

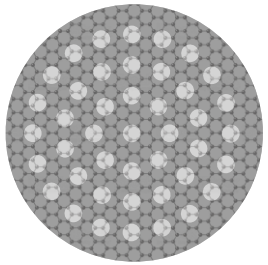
Reduced graphene oxide (rGO)



8 mm

Come aumentare la quantità di idrogeno immagazzinato

H:Graphene on TEM grid

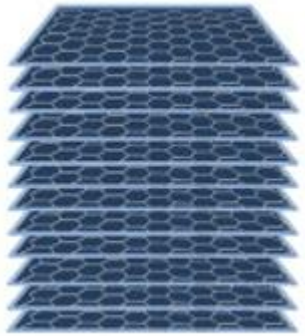


Corrisponde circa a π mm^2 e quindi a 1 ng di Trizio

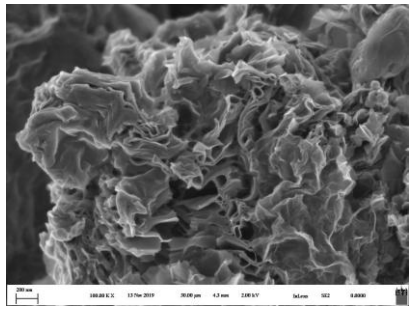
Obiettivo 1 μg di Trizio ovvero aumentare di un fattore 1000 la quantità

Come realizzare questo obiettivo

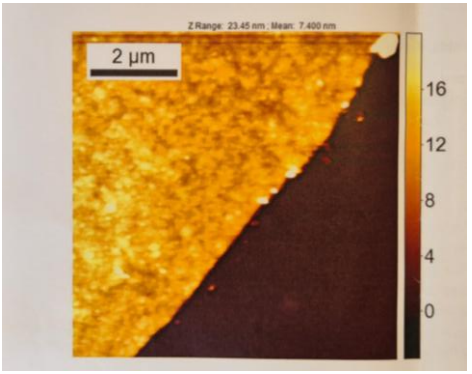
- Aumentare semplicemente di un fattore 1000 il numero di griglie
- Aumentare la superficie di circa un fattore 20 e «impilare 50 strati di grafene» (corrispondono ad uno spessore di materiale equivalente inferiore a 20 nm)

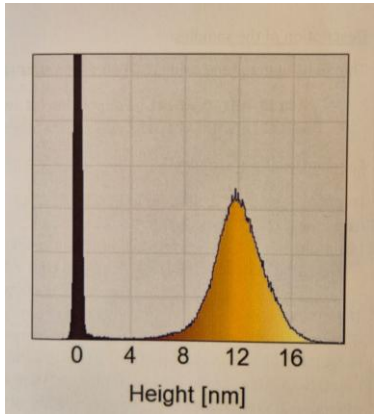


H: Reduced graphene oxide (rGO)



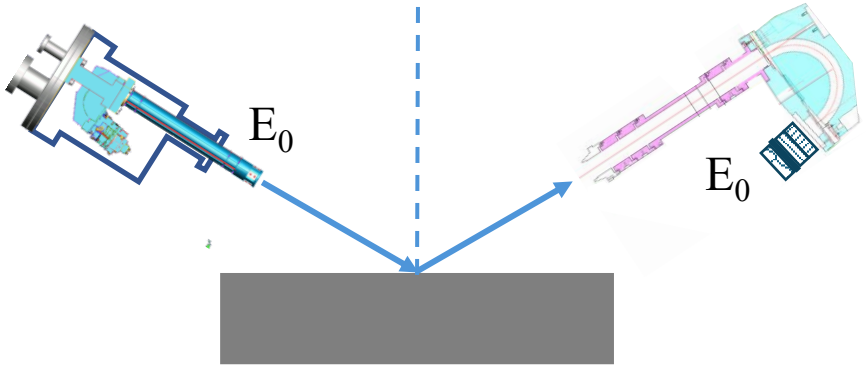
Corrisponde circa a 60 mm^2

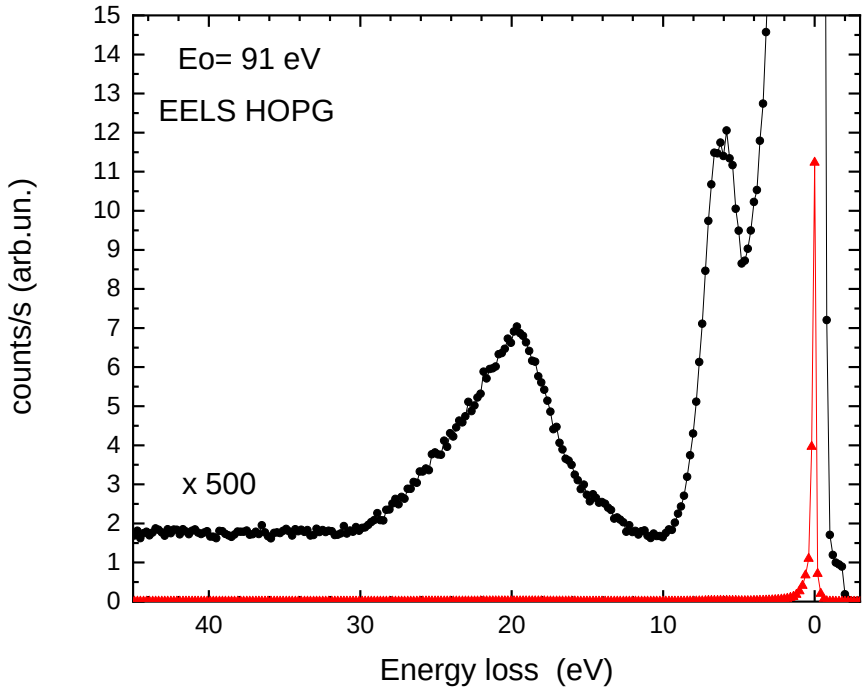




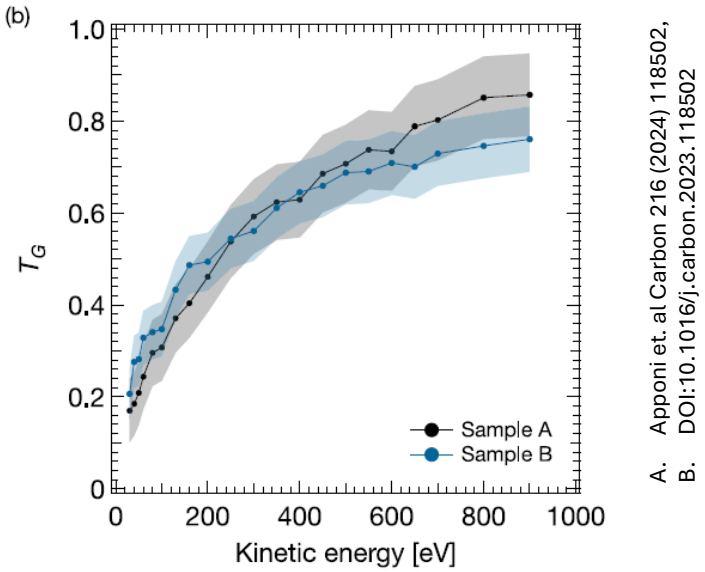
Backscattering e attenuazione non sono un problema

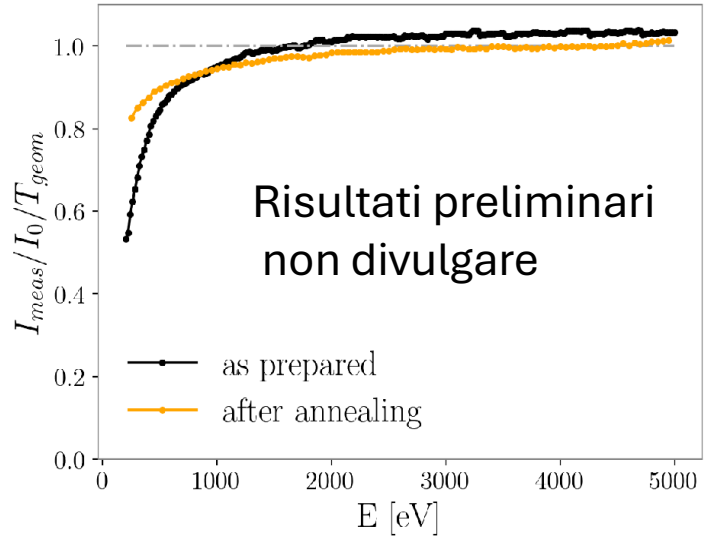
Electron (back-)scattering





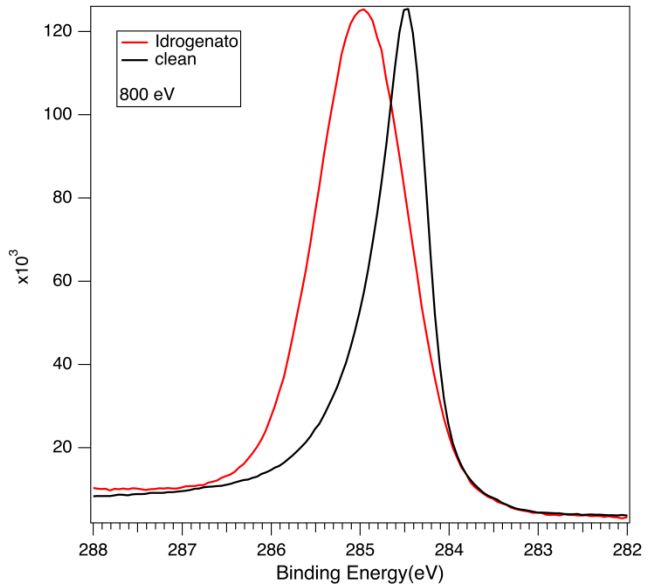
Trasmissione di e⁻ attraverso grafene

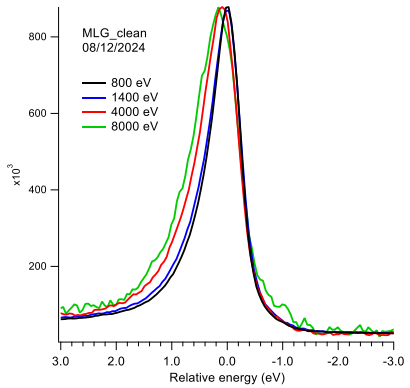


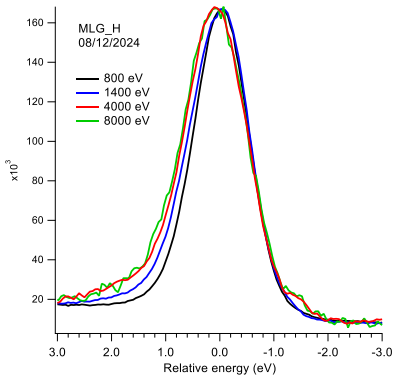


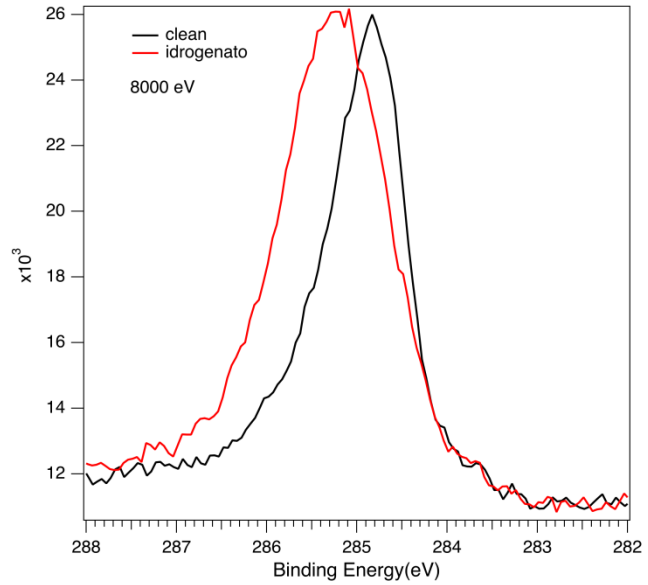
Risultati preliminari
non divulgare

Misure di fotoemissione ad alta energia (max hν=8 keV)



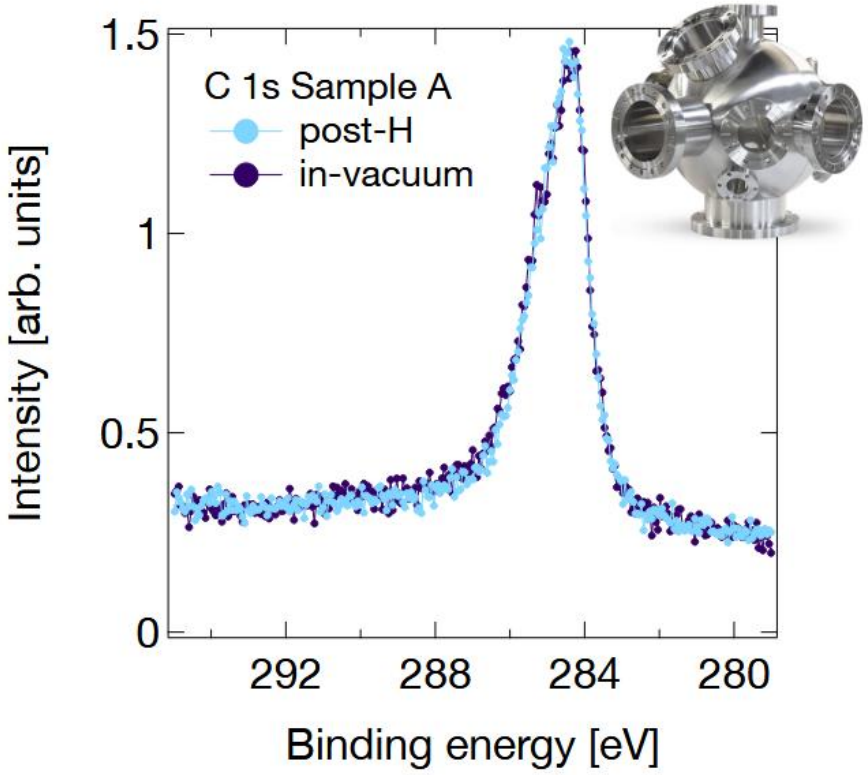






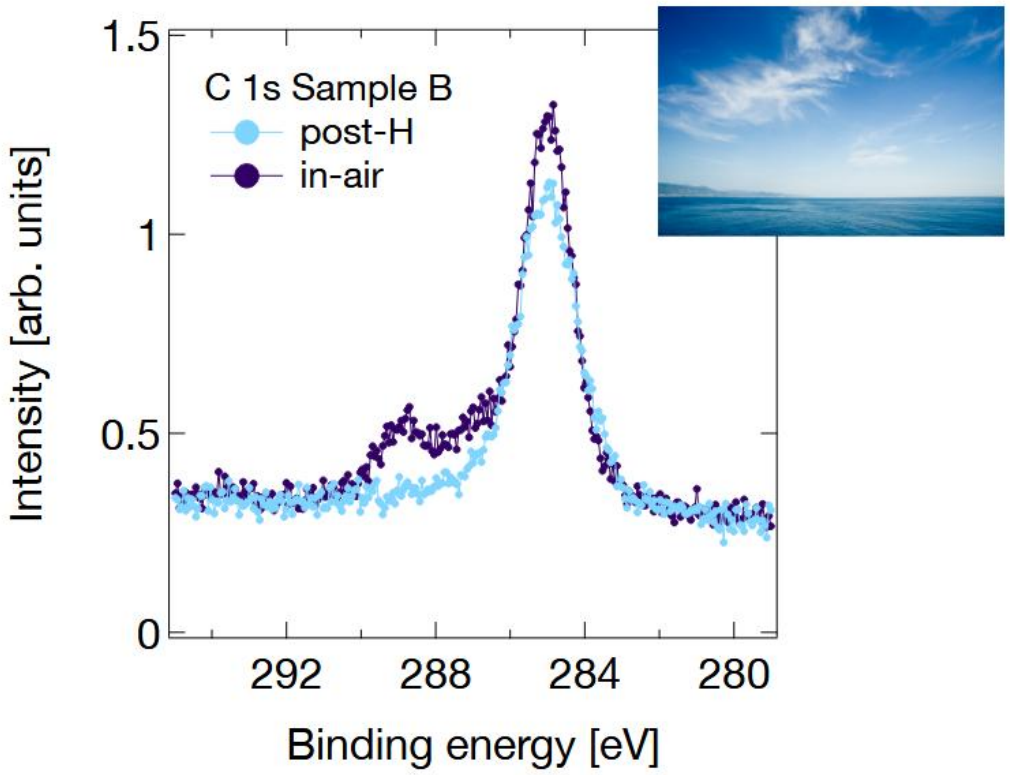
Risultati preliminari – non divulgare

Stabilità del grafene idrogenato in UHV



Sample A:

- 4 months in ultra-high vacuum (10^{-10} mbar)
- Almost unchanged

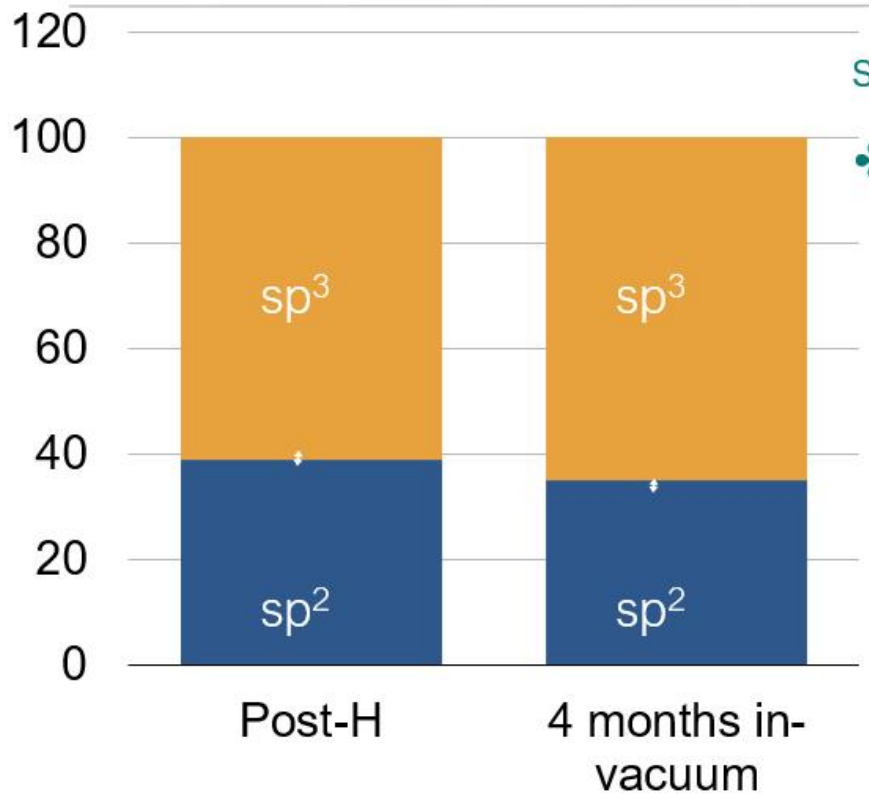


Sample B:

- 11 months in air
- Significant oxidation

Apponi et al., “Stability of Highly Hydrogenated Monolayer Graphene in Ultra-High Vacuum and in Air”, arXiv (2025), https://doi.org/10.48550/arXiv.2504.11853

Stabilità del grafene idrogenato in UHV



sp^3 relative variation:

✤ 4 ± 2 %

~10^{-10} mbar!

4 months