

# Zigzag edge formation on Graphene and Graphite by Hydrogen/Deuterium Plasma

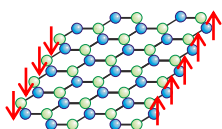
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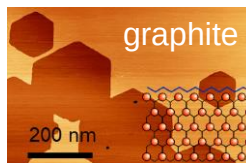
## Spin-Polarized Zigzag Edge State [1]

Edge should be

1. atomically precise zigzag structure
2. **sp<sup>2</sup>** bonded and terminated by 1 H

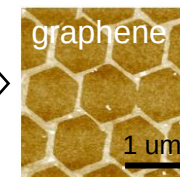


## Hydrogen Plasma Etching (HPE)

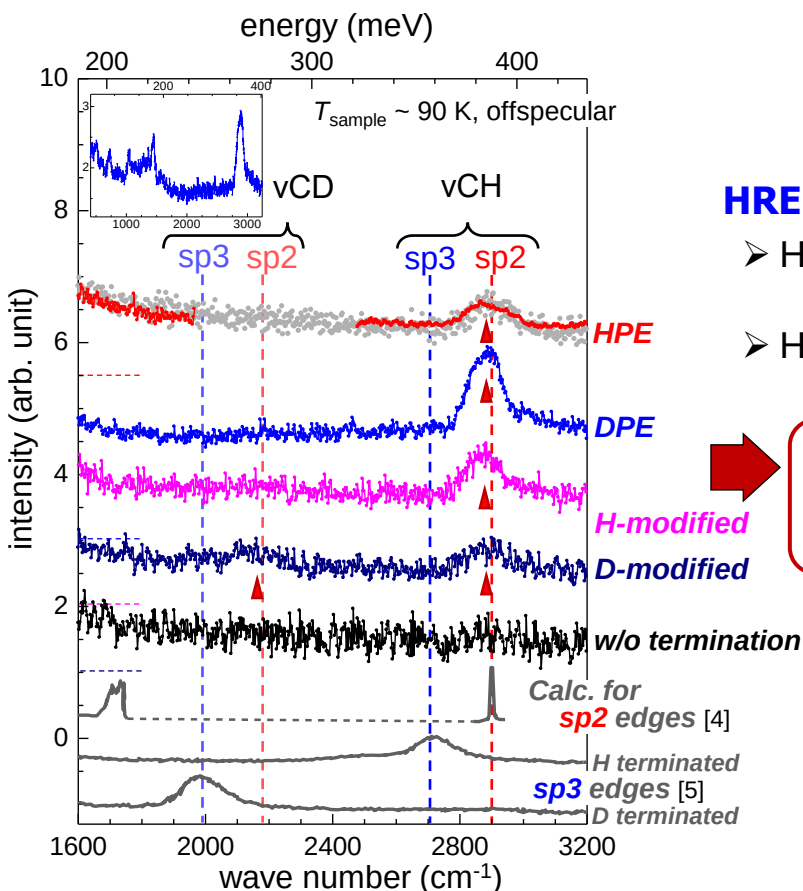


**Atomically precise zigzag (zz) edges** can be fabricated.

... confirmed by STM/S [2,3].

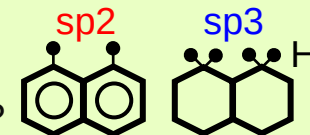


Possible to design graphene nano-structure with zigzag edges



## MOTIVATION:

- How are the zigzag edges terminated ?
- How robust the zigzag edges are in air ?



## HREELS (High Resolution Electron Energy Loss Spectroscopy) studies for

- Hydrogen / Deuterium Plasma Etched (HPE / DPE) graphite prepared *ex-situ* from HREELS chamber
- H / D modified graphite prepared *in-situ* in HREELS chamber using DPE graphite

## Energy loss

at 2900 cm<sup>-1</sup> for all samples  
at 2180 cm<sup>-1</sup> for D-modified

Stretching mode of  
**sp<sup>2</sup>** C-H/D (vCH / vCD)

\* vCD peak is weak in *this* sample preparation condition.

## SUMMARY:

- Edges are **sp<sup>2</sup>** bonded and terminated by one H atoms.
- Edge structure and termination are robust even in air.

[1] M. Fujita *et al.*, J. Phys. Soc. Jpn. **65**, 1920 (1996). [2] TM *et al.*, J. Phys. Chem. C **123**, 22665 (2019). [3] A.E.B. Amend, TM *et al.*, e-J. Surf. Sci. Nanotech. **16**, 72 (2018). [4] M. Vandescuren *et al.*, Phys. Rev. B **78**, 195401 (2008). [5] A. Dinger *et al.*, Surf. Sci. **421**, 17 (1999).