Advanced Functional Materials for Energy and Environmental Applications

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Highlights

- Life in Japan
- Research in Japan as JSPS fellow
- Ongoing research area
- Conclusion

Life in Japan


Summer

Autumn


Winter

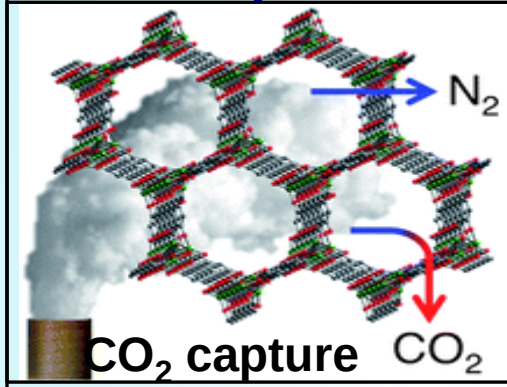

Spring

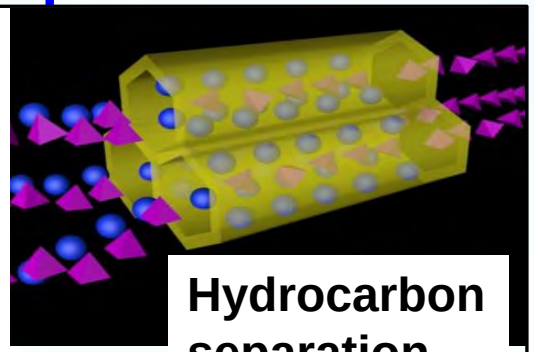

Mount Fuji

Life in Japan

Research in Japan: Energy & Environment

Gas sorption & separation



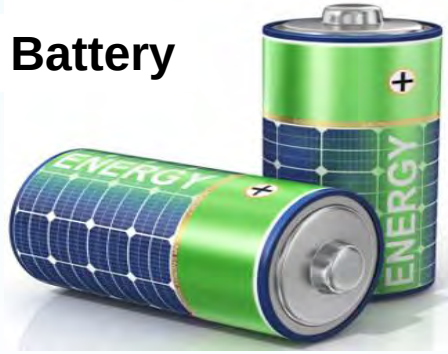


Hydrocarbon separation

Energy storage & Energy conversion

Fuel Cells or fuel storage

Battery



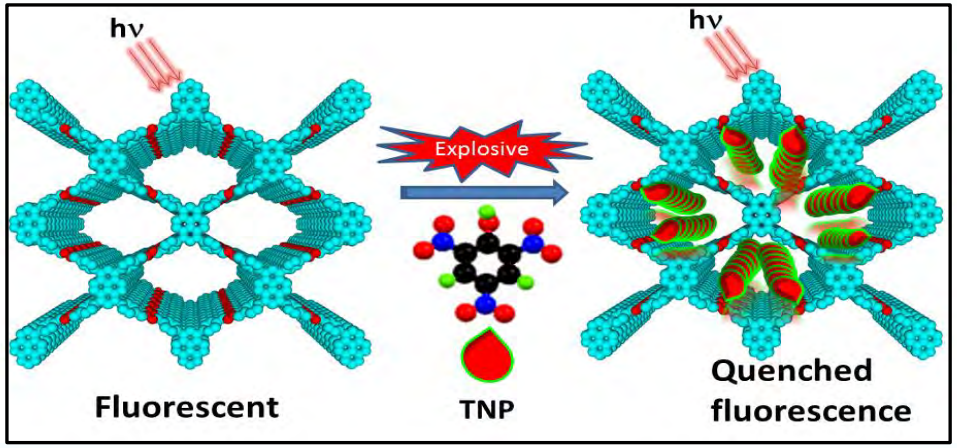
Solar Cells

Air pollutions

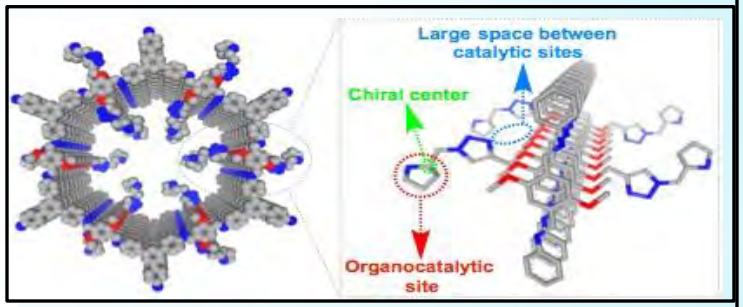
Water pollutions

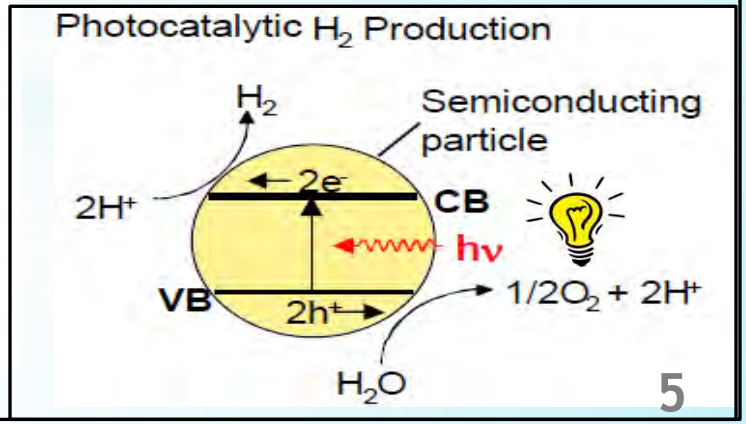
Advanced Functional Materials

Sensors



Heterogeneous catalyst



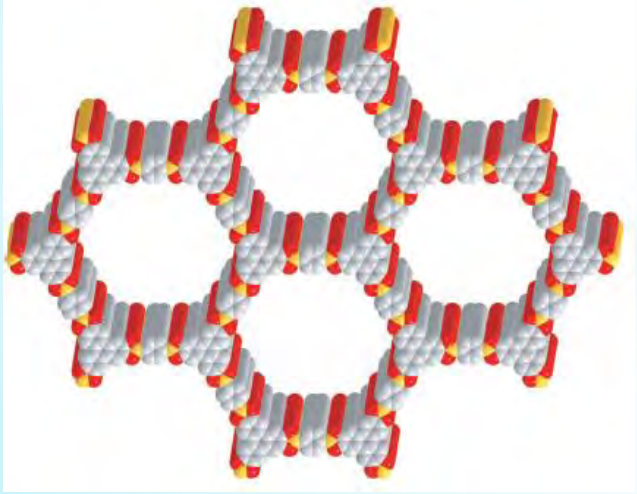


Picture Credit: https://en.wikipedia.org/wiki & Jiang group

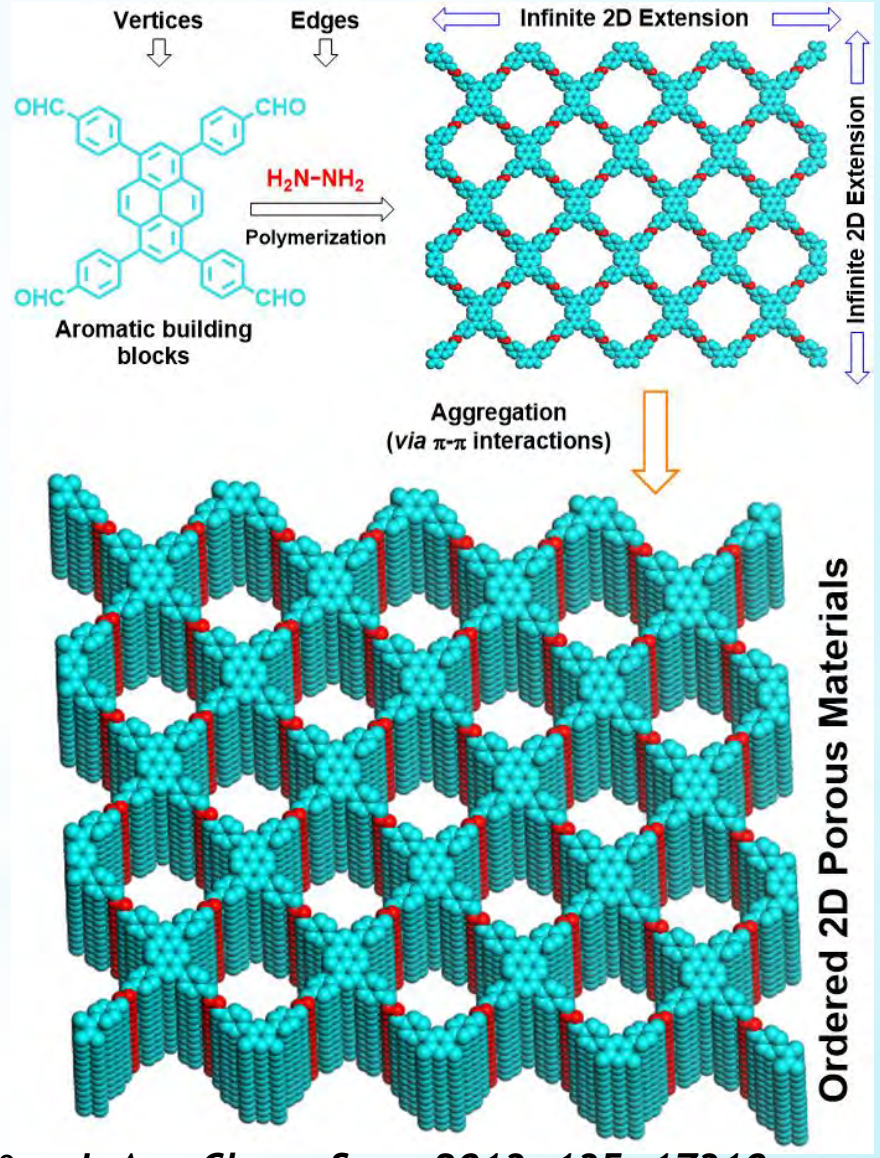
Covalent Organic Frameworks

Natural Honeycomb

Synthetic COF-5



- **Strong Covalent Bonds**
  (Robust polymers)
- **High Crystallinity**
  (Long-range Order)
- **Light-Weight Elements**
  (C, H, B, O, N; soft materials)
- **Tunable Pore Size**
  Micropore (< 2 nm)
  Mesopore (> 2 nm)
- **High Surface Area**
  (Porous polymers)

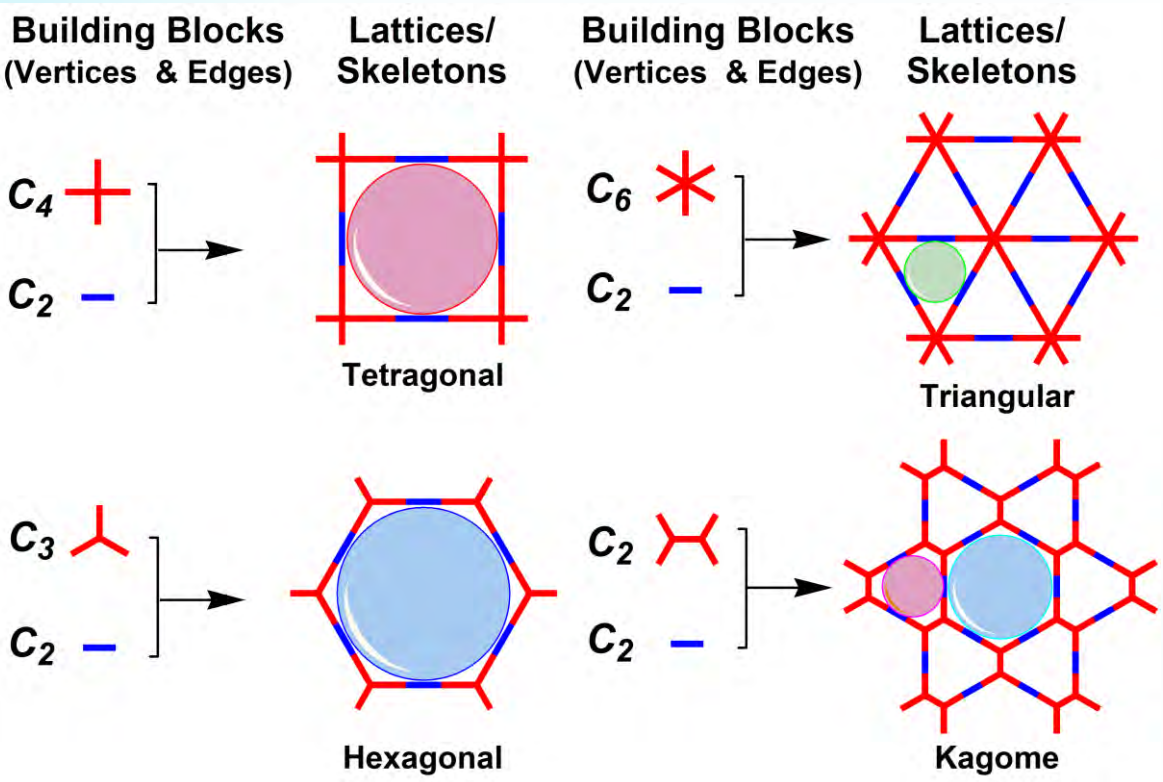


O. M. Yaghi, *et*, al., *Science*, 2005, 310, 1166; D. Jiang, *et*, al., *Chem. Soc. Rev.*, 2012, 41, 6010. ***J. Am. Chem. Soc., 2013, 135, 17310.***

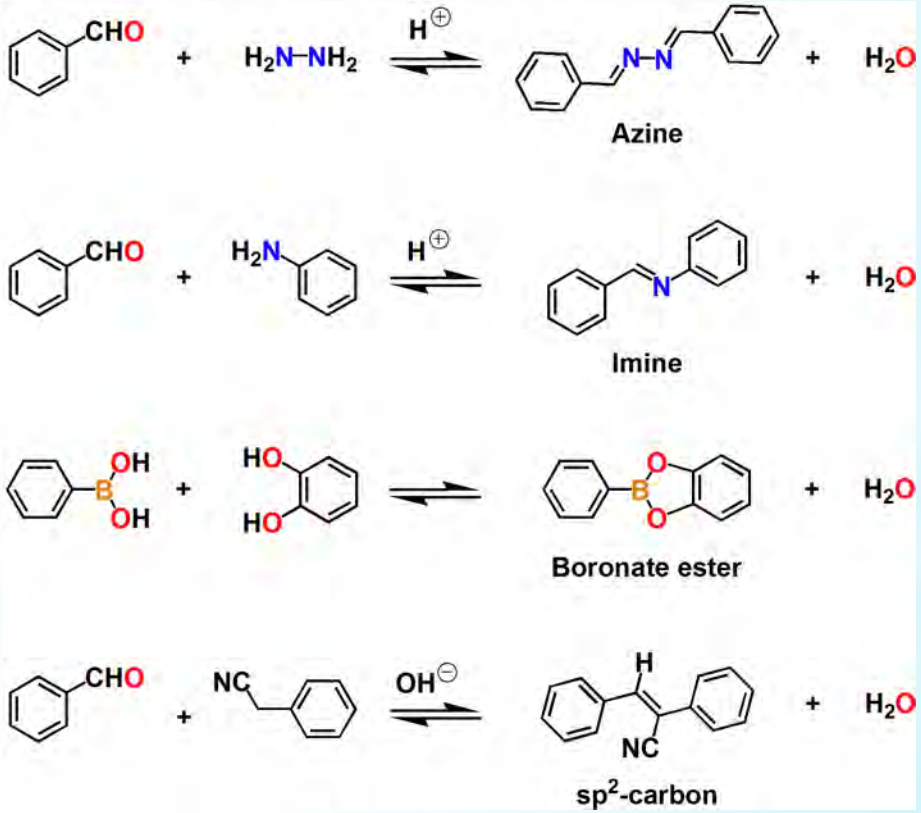
Research in Japan

Tools: Design; controlled preparation; topology guided structure and functions

Topology diagram for 2D COFs and pore mapping



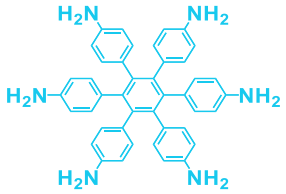
Reversible chemical bond formation reaction



J. Am. Chem. Soc., 135, 17310 (2013); 138, 5797 (2016); Nat. Commun., 6:7786 (2015); E. Jin, et, al., Science, 357, 673 (2017).

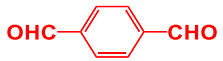
Research in Japan

Vertices → C_6



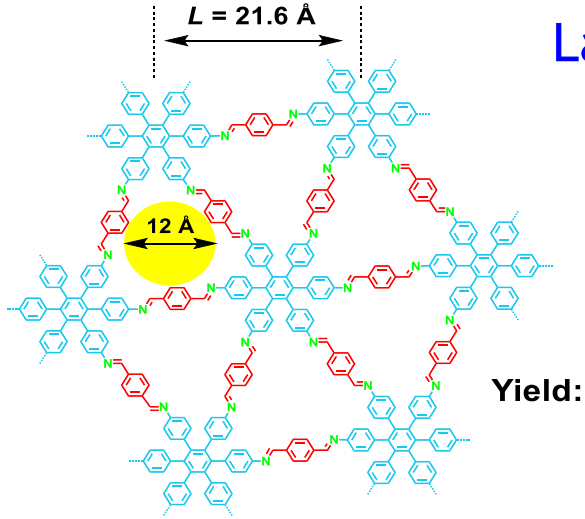
$[H_2N]_6HPB$

Edges → C_2

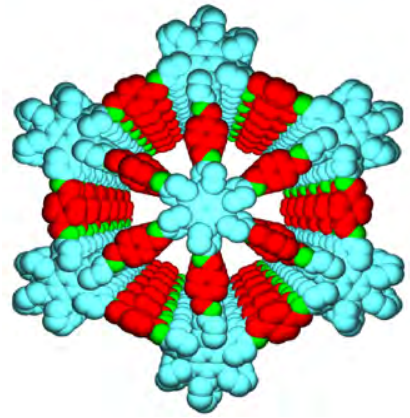


Toluene
120°C
9-days

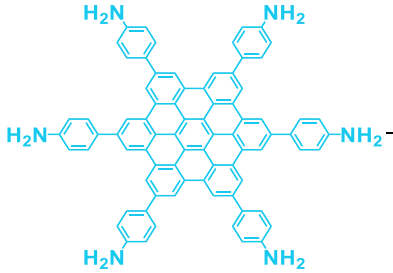
Lattices



Yield: 70%

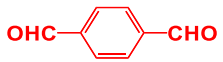


HPB-COF

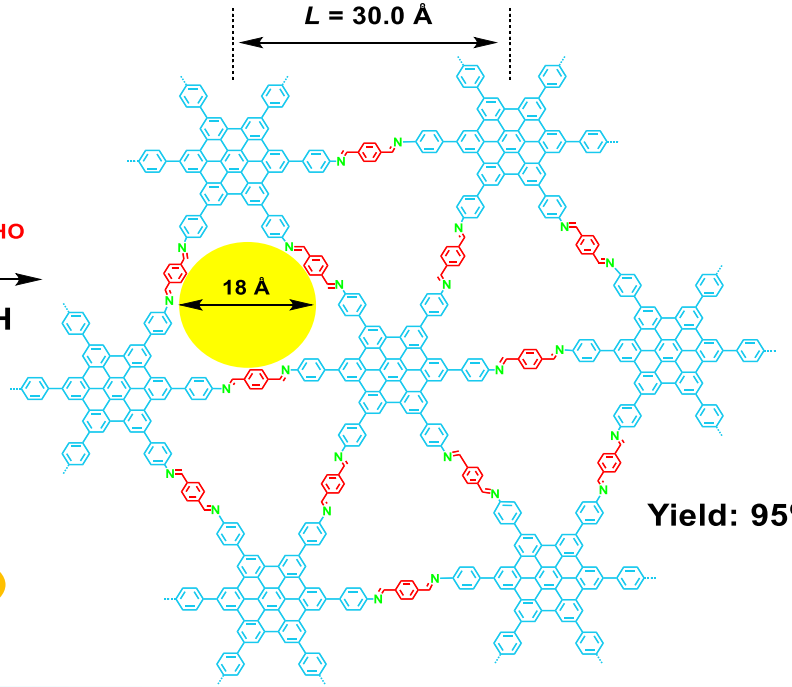


$[H_2N]_6HBC$

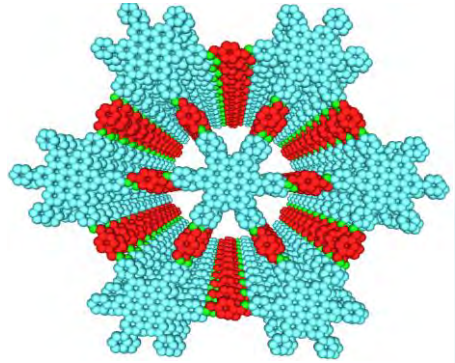
C_2



DOX/BuOH
120°C
12-days



Yield: 95%



HBC-COF

Triangular topology

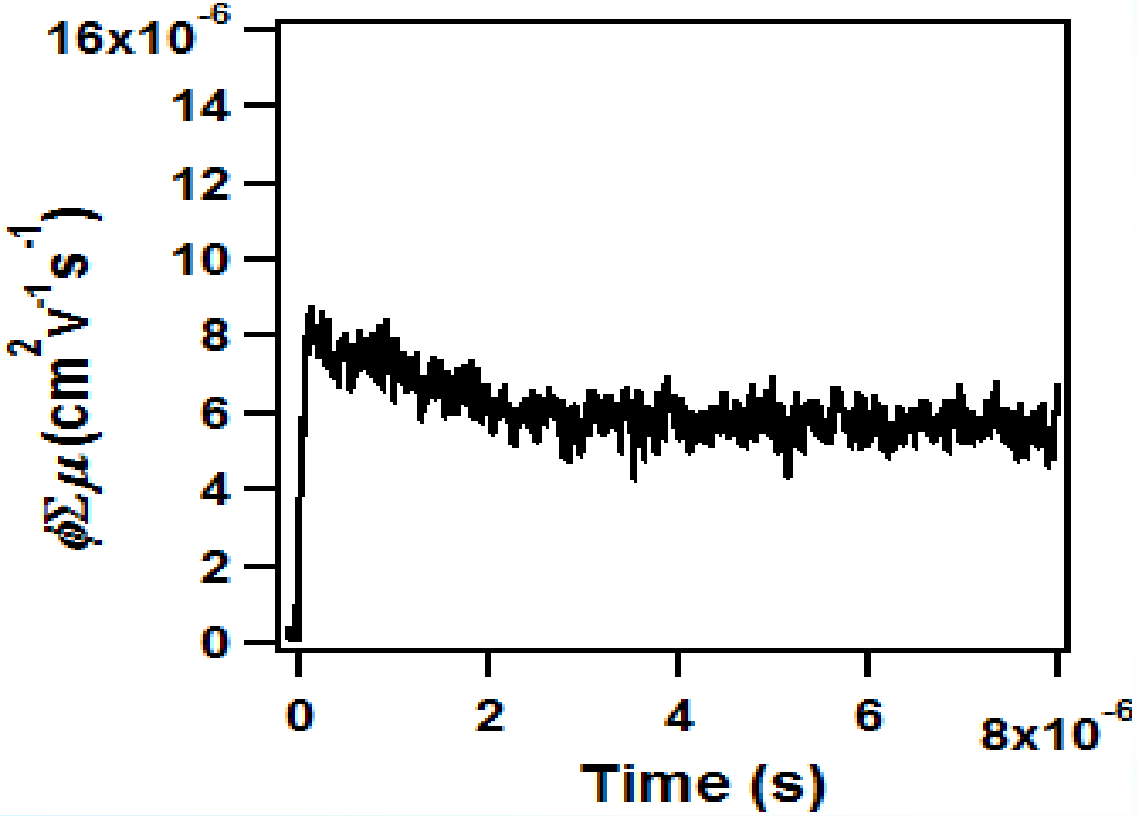
Outcome:

- ✓ New topology
- ✓ Crystalline
- ✓ Supermicroporous
- ✓ High π-density
- ✓ Robust polymer
- ✓ Photoconductive

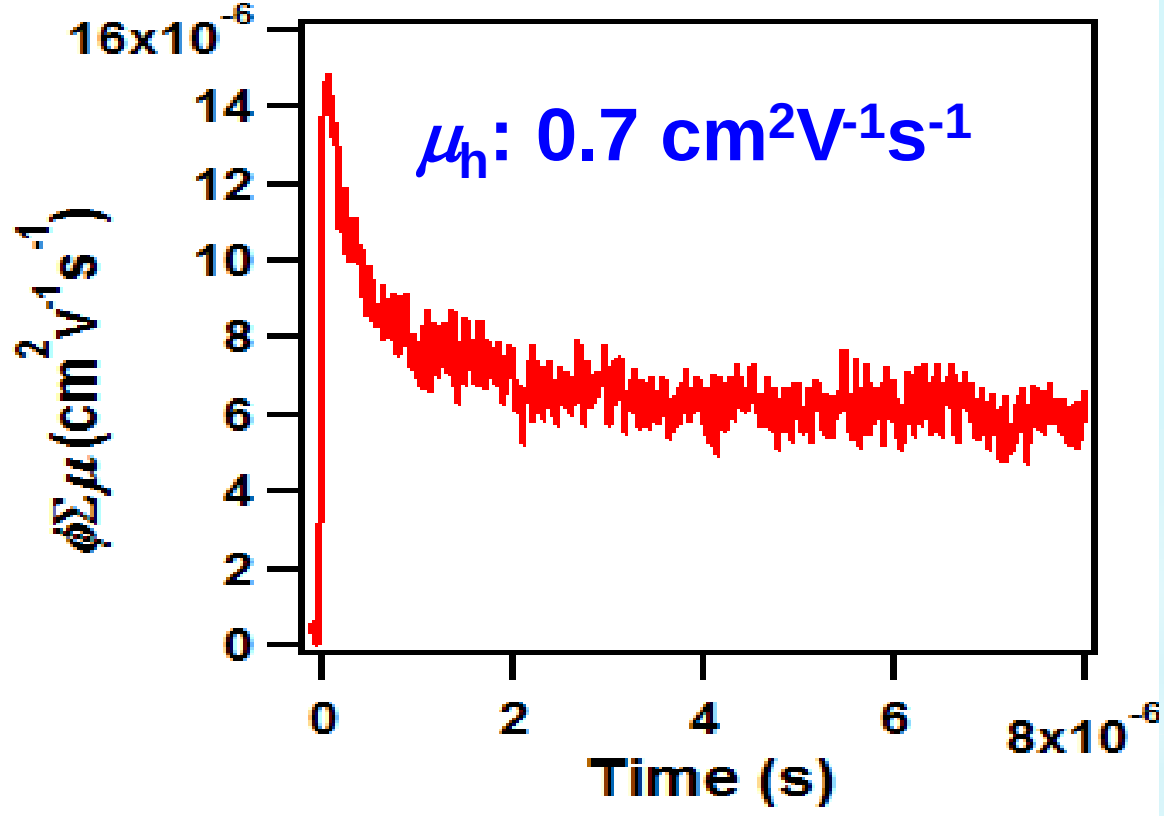
Nat. Commun., 2015, 6:7786.

Research in Japan

HPB-COF



HBC-COF



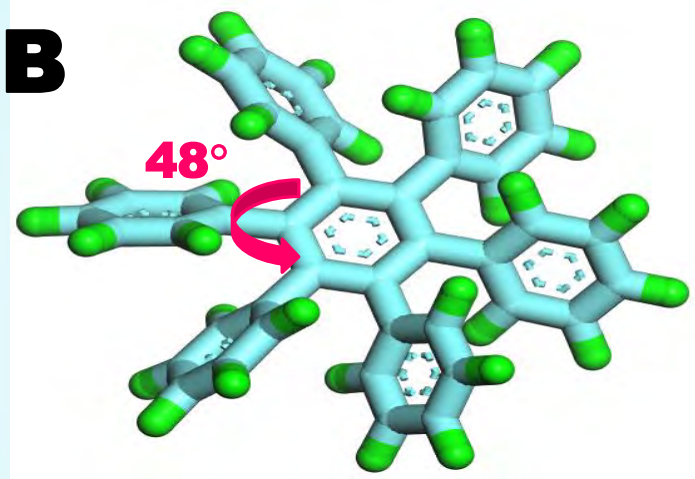
$\phi\Sigma\mu$ = 0.8×10^{-5} cm^{2}V^{-1}s^{-1}

$\phi\Sigma\mu$ = 1.5×10^{-5} cm^{2}V^{-1}s^{-1}

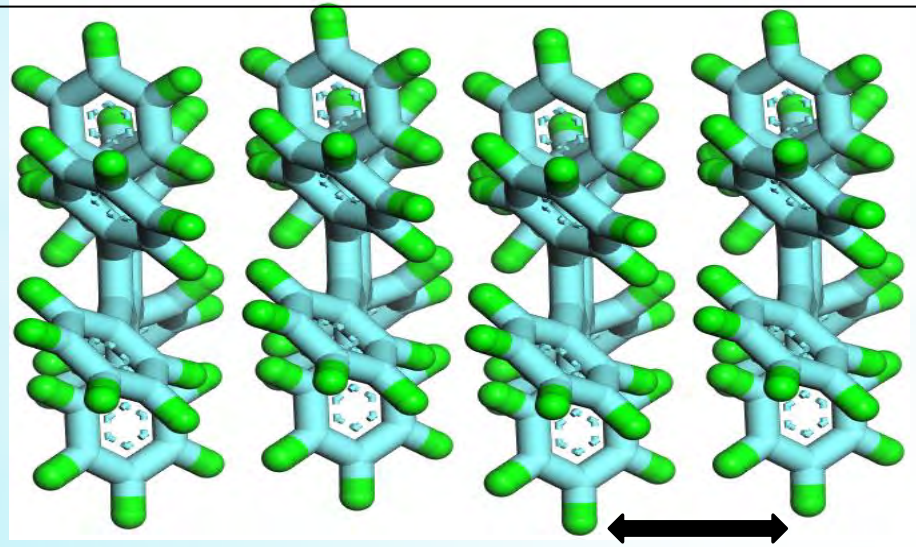
FP-TRMC Methods: S. Seki, *et,* al., *Acc. Chem. Res.* 2012, 45, 1193.

Research in Japan

HPB

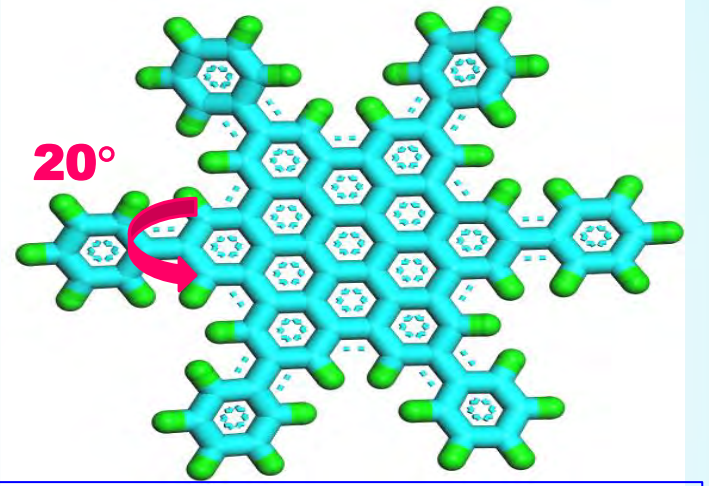


Propeller shape, weak π column

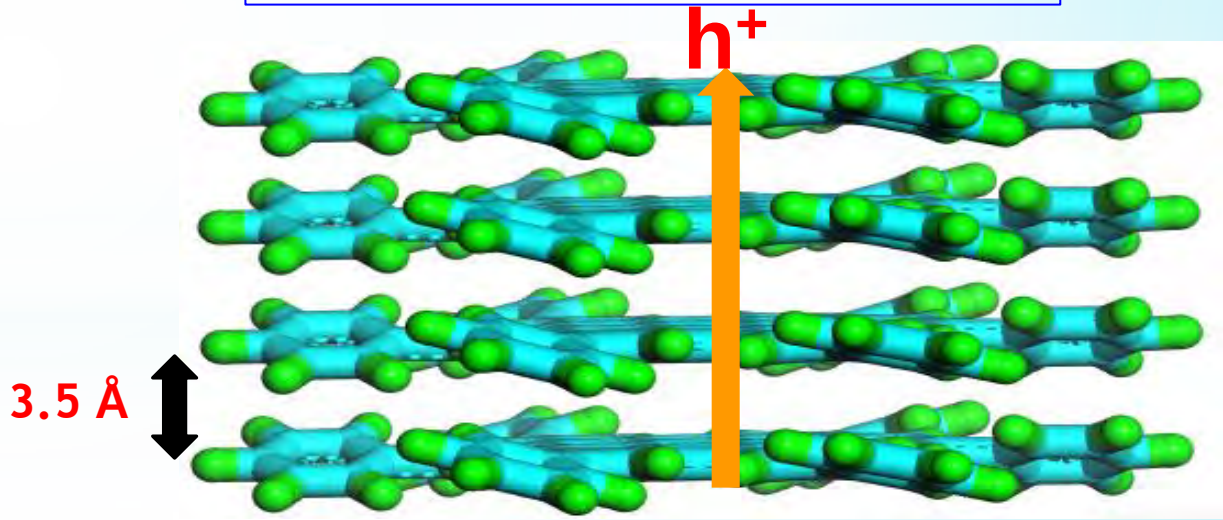


E_{stack}: 46.7 kcal mol^{-1}

HBC



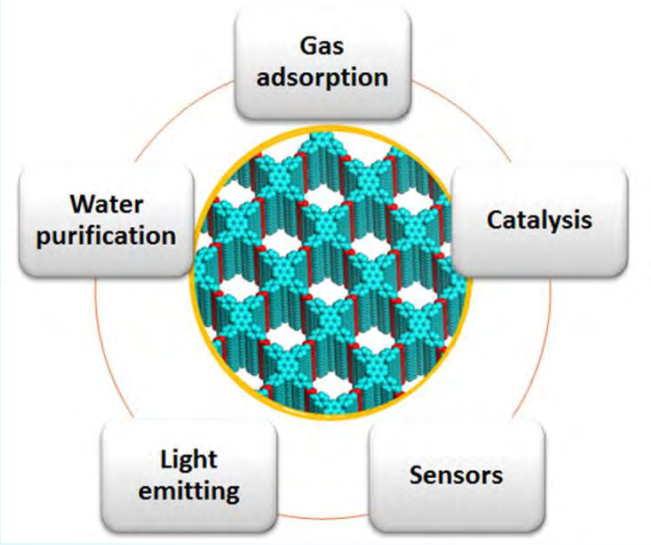
Large PAHs, strong π column



E_{stack}: 136.4 kcal mol^{-1}

Ongoing research area

Multifunctional Materials Lab



Research Projects:

- Aggregation induced emission (AIE) based light emitting material and covalent organic frameworks – applications (DST-Inspire, India)
- 'Investigation on the effectiveness of *eggshell bio-waste* for multi-stage water purification' (SERB-SRG, India)
- Room temperature phosphorescent (RTP) materials for OLED applications.
- Nanographitic coronene-based materials for optoelectronic applications

Related articles:

- S. Mondal, S. Ruidas, K. K. Halankar, B. P Mandal, **S. Dalapati**, A. Bhaumik, ***Energy Advances*, 2022**, DOI: 10.1039/d2ya00148a.
- S. Ruidas, A. Das, S. Kumar, **S. Dalapati**, U. Manna, A. Bhaumik, ***Angew. Chem. Int. Ed.*, 2022**, DOI: org/10.1002/ange.202210507, I.F. 16.823.
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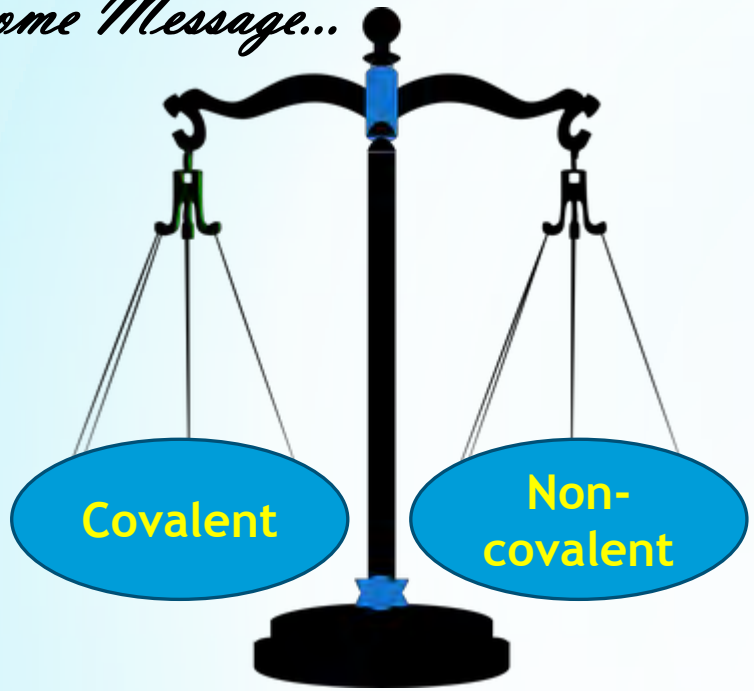
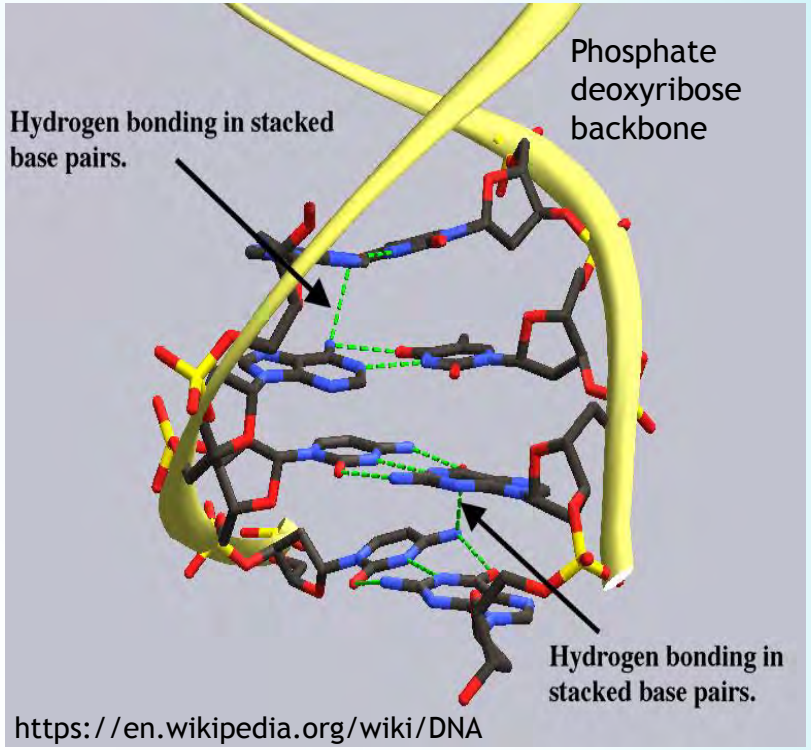
- E. Jin, M. Asada, Q. Xu, **S. Dalapati**, M. Addicoat, M. A Brady, H. Xu, T. Nakamura, T. Heine, Q. Chen, D. Jiang, ***Science***, **2017**, 357, 673-676, I.F. 63.714.
- **S. Dalapati**, E. Jin, M. Addicoat, T. Hein, D. Jiang, ***J. Am. Chem. Soc.***, **2016**, 138, 5797-5800 (**highlighted in ACS select virtual issue**, **Press released** at JAIST, Japan), I.F. 16.383.
- **S. Dalapati**, C. Gu, D. Jiang, ***Small***, **2016**, 12, 6513-6527 (**Review Article**), I.F. 15.15.
- **S. Dalapati**, M. Addicoat, S. Jin, T. Sakurai, J. Gao, H. Xu, S. Irle, S. Seki, D. Jiang, ***Nat. Commun.*, 2015**, 6:7786, I.F. 17.69.
- **S. Dalapati**, S. Jin, J. Gao, Y. Xu, A. Nagai, D. Jiang, ***J. Am. Chem. Soc.***, **2013**, 135, 17310-17313, I.F. 16.383.

Home Message...



Ordered network...

Biopolymers



Crystalline polymers

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Thank you!

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