Solution-Gated Nanoporous Graphene Field-Effect Transistors

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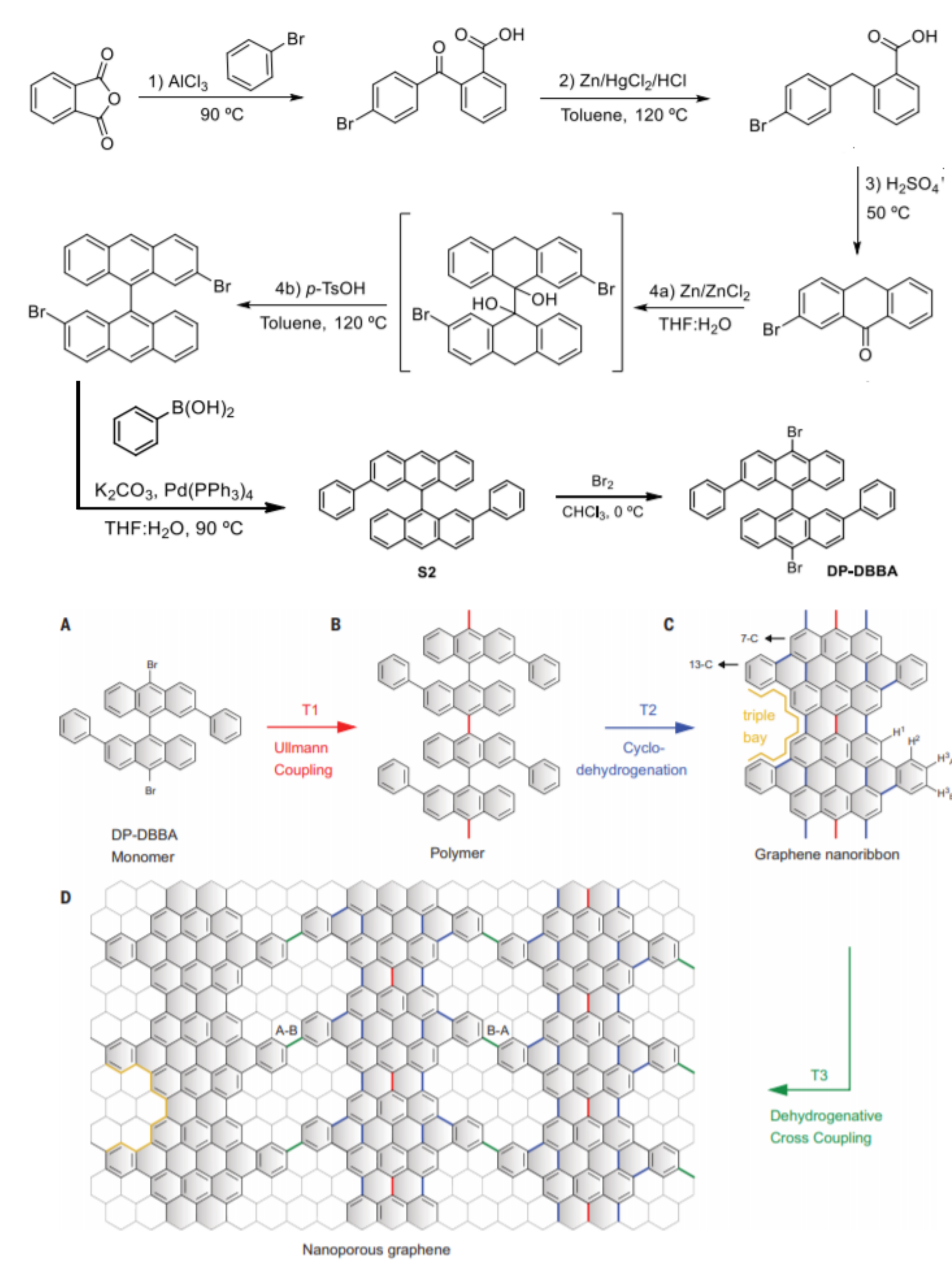
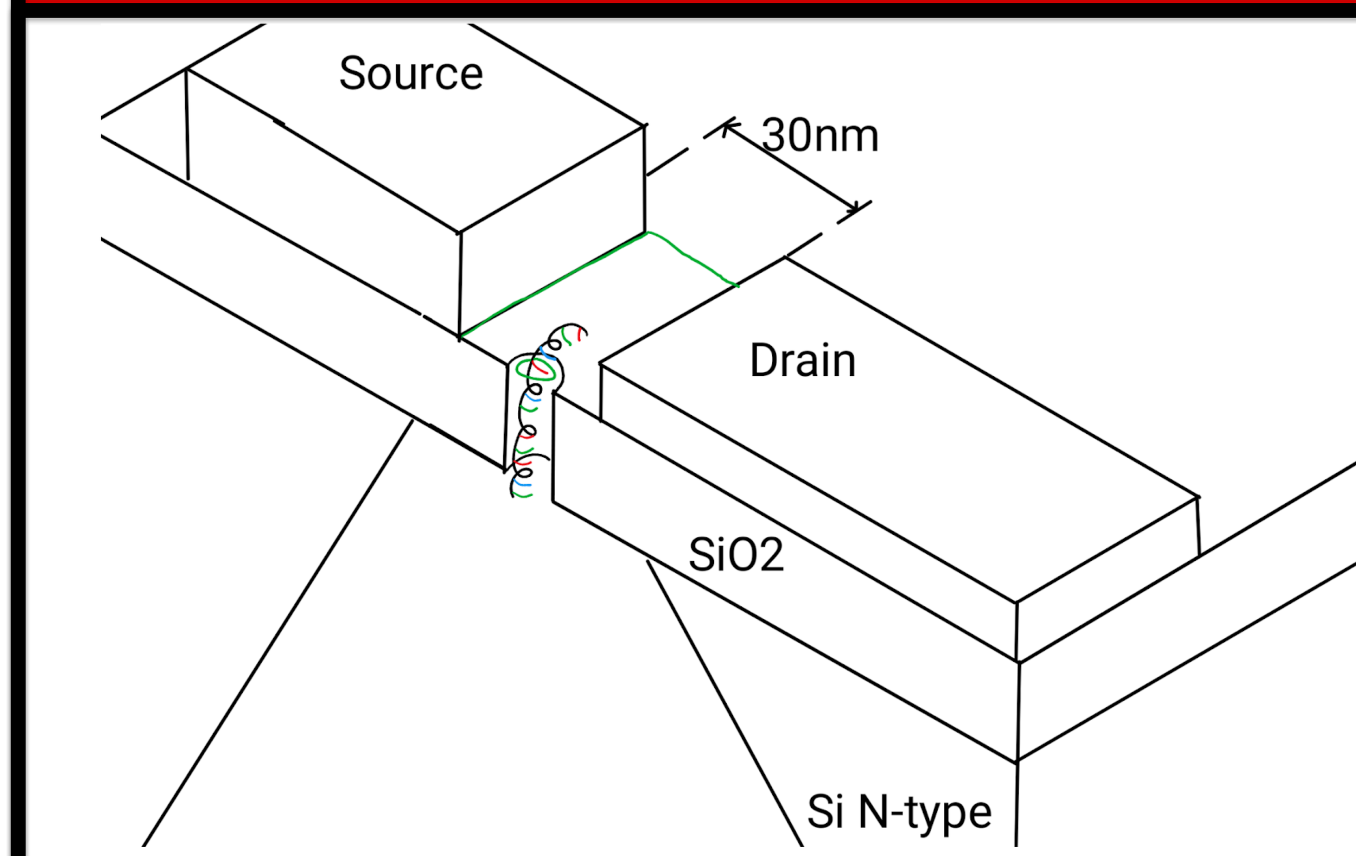
Background

- As a continuous lattice of conjugated, π-bonded carbons, graphene and nanoporous graphene hold promise for electronic sensors and atomically thin molecular sieves.
- Potentially enabling single molecule qualitative analysis and high throughput dialysis and desalination membranes
- 10^{13} pores/cm^2
- Pore Dimensions: 4Å x 9Å
- Electrostatic interactions between molecules generates a small signal response in drain-source current.

Synthesis Pathway[1,2]



Nanopore FET



- A single nanopore is formed by controlled dielectric breakdown.
- An Axopatch voltage clamp amplifier measures ionic current blockages. Bias voltage determines doping of the graphene channel
- A high-speed, low noise transimpedance amplifier is designed to integrate with CMOS foundry fabrication processes.

Nanoporous Graphene - Sieve

- Synthesizing nanoporous graphene from the bottom up requires atomically flat crystal surfaces. The sub-nanometer roughness of the Gold <111> facet specifically guides the formation of nanoporous graphene.
- A custom Knudsen cell is made to deposit atomic layers of monomers. A heating stage thermally induces polymerizations to yield nanoporous graphene from cyclodehydrogenative cross coupling.
- For the dialysis membrane, samples are transferred onto 200nm polycarbonate track etched supports followed by interfacial polymerization to seal large scale defects. UV/Vis Spectrophotometry were used to measure permeance of L-tryptophan and Lysozyme.

Future Challenges

- Input Impedance and Parasitic Capacitances
- Signal to Noise Ratio

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References

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- (2) de Oteyza, Dimas G., et al. "Supplementary information: Substrate-independent growth of atomically precise chiral graphene nanoribbons." ACS nano10.9 (2016): 9000-9008.