Center for Nanostructured Graphene - Highlights in 2018

Conductance Quantization Suppression in the Quantum Hall Regime

The quantum Hall effect is one of the hallmarks of two-dimensional conductors – such as graphene. When a powerful magnetic field is applied to a graphene system, the current creeps along the edges in quantum-mechanical edge states. The QHE is normally considered highly robust towards edge disorder, but José Caridad and his coworkers showed that, in fact, the absence of edge disorder can disrupt QHE from quantizing the conductance. By carefully fabricating narrow samples with different degrees of edge disorder and measuring these in different magnetic fields, the team showed that in graphene with very low edge disorder (1 nanometer), an enhanced charge accumulation leads to new edge states being formed, and ultimately to the collapse of the conductance quantization. The existence of this regime was theoretically predicted several years ago, but was not observed until now in actual devices. These findings may have a profound impact on fundamental studies of quantum transport in finite-size, two-dimensional crystals with low disorder.

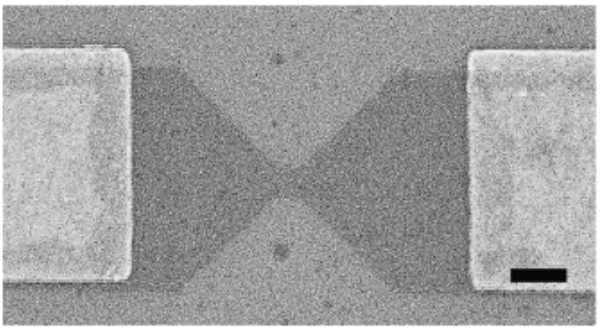

Figure 1. Scanning electron micrograph of a nanoconstriction device with 1 nanometer edge roughness. The dark grey area is the graphene device, and the lightest areas are electrical contacts. Scale bar is 200 nm.

Caridad, J.M., Power, S. R., Lotz, M. R., Shylau, A. A., Thomsen, J. D., Gammelgaard, L., Booth, T. J., Jauho, A.P. and Bøggild, P. (2018) *Conductance quantization suppression in the quantum Hall regime*, Nature Communications **9** (1), 659, doi: 10.1038/s41467-018-03064-8

The Computational 2D Materials Database (C2DB)

Over the past decade, atomically thin two-dimensional (2D) materials have made their way to the forefront of several research areas including batteries, (electro-) catalysis, electronics, and photonics. This development was prompted by the intriguing and easily tunable properties of atomically thin crystals and has been fueled by the constant discovery of new 2D materials and their emergent properties, which open completely new possibilities for designing materials with tailored and superior properties.

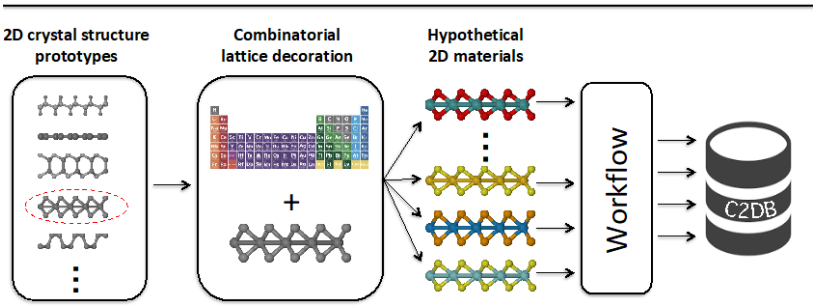

Figure 2. The materials in the C2DB are initially generated by decorating an experimentally known crystal structure prototype with atoms chosen from a (chemically reasonable) subset of the periodic table.

Kristian Thygesen and his research team have developed the comprehensive database C2DB (The Computational 2D Materials Database, which presents a variety of ab-initio calculated properties of around 4000 2D materials. A large number of new, potentially synthesizable 2D materials with interesting properties are identified targeting applications within spintronics, (opto-)electronics, and plasmonics.

The C2DB offers a comprehensive and easily accessible overview of the rapidly expanding family of 2D materials and forms an ideal platform for computational modeling and design of new 2D materials and heterostructures. The database is fully open and can be browsed online (http://c2db.fysik.dtu.dk) or downloaded in its entirety.

Haastrup, S., Strange, M., Pandey, M., Deilmann, T., Schmidt, P. S., Hinsche, N. F., Gjerding, M. N., Torelli, D., Larsen, P. M., Riis-Jensen, A. C., Gath, J., Jacobsen, K. W., Mortensen, J. J., Olsen, T. and Thygesen, K. S. (2018) *The computational 2D materials database: High-throughput modeling and discovery of atomically thin crystals*, 2D materials **5** (4), 042002, doi: 10.1088/2053-1583/aacfc1