24th International Conference on High Magnetic Fields in Semiconductor Physics,
4-7 July 2022, Hong Kong

CVD graphene in high magnetic fields

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The chemical vapor deposition (CVD) of the 2D material graphene on copper substrates is among the most promising candidates for its scalable synthetization. However, for years the quality of the so-derived graphene was inferior to the reference material exfoliated from graphite crystals. This changed in 2015 when a dry-transfer technique for removing the graphene from the growth substrate was introduced yielding highest quality graphene devices [1]. Although record high carrier mobilities and structural properties could be achieved, evidence of fragile interaction-mediated phenomena like the fractional quantum Hall effect (FQHE) was still missing as an ultimate proof of the equality of the CVD derived graphene to exfoliated material.

In this work we demonstrate for the first time the FQHE in dry-transferred CVD graphene devices for magnetic fields from below 3 T to 35 T. Effective composite fermion (CF) filling factors up to $\nu^* = 4$ are visible and higher order CF states emerge at the highest fields. The p/3 fractional quantum Hall states have energy gaps of up to 30 K, well comparable to those observed in other silicon-gated devices based on exfoliated graphene and thereby validating the intrinsic quality of CVD derived graphene as well as opening the door to future experiments that make use of the scalability of the CVD process [2].

In a further collaboration, we investigate the role of disorder for the manifestation of the QHE at room temperature in an ensemble of graphene transport devices fabricated by different methods resulting in varying degrees of sample disorder, where our dry-transferred CVD graphene devices constitute the highest quality set of samples. We find increasing QHE breakdown temperatures with increasing sample disorder level and, even more crucially, that pronounced Hall plateaus at room temperature are only present in highly disordered devices confirming the so far unproven assumption, that disorder remains a necessary ingredient for the QHE at such elevated temperatures [3].

[1] Banszerus et al., Sci. Adv., **1**, 6, (2015)

[2] Schmitz et al., 2D Mater., **7**, 041007, (2020)

[3] Schmitz et al., *in preparation*, (2022)