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Basal-plane dislocations in bilayer graphene - Peculiarities in a quasi-2D material[1]

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Dislocations represent one of the most fascinating and fundamental concepts in materials science. First and foremost, they are the main carriers of plastic deformation in crystalline materials. Furthermore, they can strongly alter the local electronic or optical properties of semiconductors and ionic crystals. In layered crystals like graphite dislocation movement is restricted to the basal plane. Thus, those basal-plane dislocations cannot escape enabling their confinement in between only two atomic layers of the material. So-called bilayer graphene is the thinnest imaginable quasi-2D crystal to explore the nature and behavior of dislocations under such extreme boundary conditions. Robust graphene membranes derived from epitaxial graphene on SiC provide an ideal platform for their investigation. The presentation will give an insight in the direct observation of basal-plane partial dislocations by transmission electron microscopy and their detailed investigation by diffraction contrast analysis and atomistic simulations. The investigation reveals striking size effects. First, the absence of stacking fault energy, a unique property of bilayer graphene, leads to a characteristic dislocation pattern, which corresponds to an alternating AB $\leftrightarrow$ BA change of the stacking order. Most importantly, our experiments in combination with atomistic simulations reveal a pronounced buckling of the bilayer graphene membrane, which directly results from accommodation of strain. In fact, the buckling completely changes the strain state of the bilayer graphene and is of key importance for its electronic/spin transport properties. Due to the high degree of disorder in our quasi-2D material it is one of the very few examples for a perfect linear magnetoresistance, i.e. the linear dependency of the in-plane electrical resistance on a magnetic field applied perpendicular to the graphene sheet up to field strengths of more than 60 T.

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