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Exotic properties of graphene - based membranes

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Freestanding graphene, i.e. a graphene membrane, is an only one atom thick membrane with exceptional crystalline quality. Here, we report about optical and structural properties of freestanding graphene and chemically modified graphene membranes. Even though graphene is only one atom thick, we found that it absorbs a considerable amount of light (2.3%), which is defined by the fine structure constant, the parameter that describes the coupling between light and relativistic electrons. We also used graphene membranes as a scaffold for synthesizing new materials. Whereas three-dimensional graphite is an inert material, graphene is said to be highly reactive to different atomic species. By exposing graphene to atomic hydrogen, we were able to convert sp² hybridized graphene to sp³ hybridized graphane. The atomic structures of graphene membranes, as well as chemically modified graphene membranes, were investigated using atomic resolution transmission electron microscopy and electron diffraction. These studies clarified that after chemical modification the lattice constant and the corrugation of freestanding graphene is changed considerably. I will also give an overview of our latest results on structural and electronic properties of newly developed graphene derivatives.

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