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Large-Area Synthesis of High-Quality and Controllable Thickness Graphene Film by Rapid Thermal Annealing

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Abstract

Today, chemical vapor deposition (CVD) of hydrocarbon gases has been demonstrated as an attractive method to synthesize large-area graphene layers. However, special care should be taken to precisely control the resulting graphene layers in CVD due to its sensitivity to various process parameters. Therefore, a facile synthesis to grow graphene layers with high controllability will have great advantages for scalable practical applications.

In this study, we report the growth of few-layer, large-area graphene films using rapid thermal annealing (RTA) without the use of intentional carbon-containing precursor. The instability of nickel films in air facilitates the spontaneous formation of ultrathin (< 2-3 nm) carbon- and oxygen-containing compounds on a nickel surface. Therefore the high-temperature annealing of the nickel samples results in the formation of few-layer graphene films with high crystallinity. The thickness of the graphene layers is strongly dependent on the RTA temperature and time and the resulting films have a limited thickness less than 2 nm even for an extended RTA time. The transferred films have a very low sheet resistance of ~380 Ω/sq, with ~93% optical transparency, making them highly reproducible, and the thickness of the graphene layer is controlled.

This simple and potentially inexpensive method of synthesizing novel 2D carbon films offers a wide choice of graphene films for possible electronics and optoelectronic applications.