Large-area transfer of two-dimensional materials free of cracks, contamination and wrinkles via controllable conformal contact

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The availability of graphene and other two-dimensional (2D) materials on a wide range of substrates forms the basis for large-area applications, such as graphene integration with silicon-based technologies, which requires graphene on silicon with outperforming carrier mobilities. However, 2D materials were only produced on limited archetypal substrates by chemical vapor deposition approaches. Reliable after-growth transfer techniques, that do not produce cracks, contamination, and wrinkles, are critical for layering 2D materials onto arbitrary substrates. Here we show that, by incorporating oxhydryl groups-containing volatile molecules into supporting films, the supporting films can be deformed under heat to achieve a controllable conformal contact, enabling the large-area transfer of 2D films without cracks, contamination, and wrinkles. The resulting conformity with enhanced adhesion facilitates the direct delamination of supporting films from graphene, providing ultraclean surfaces and carrier mobilities up to 1,420,000 $cm^2\ V^{-1}\ s^{-1}$ at 4 K. This organic solvent-free transfer is capable for van der Waals integration with promoted interlayer coupling. With promising efficiency, our method can be applied to batch processes of 2D materials.

Figures

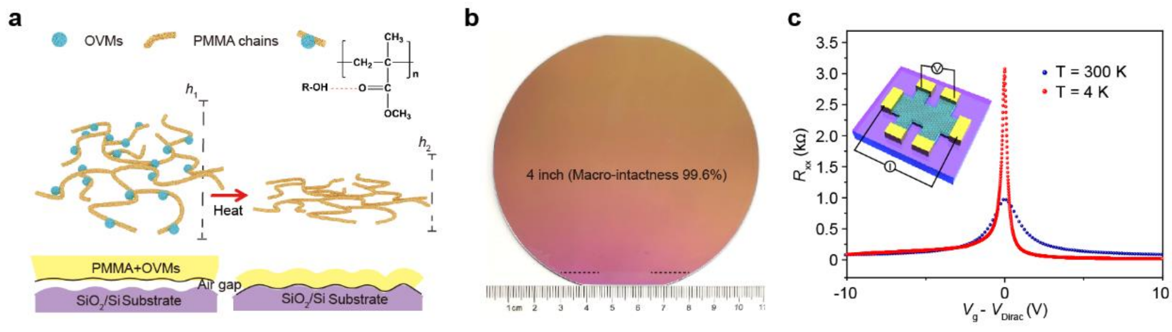

Figure: **a**, Mechanism illustration of the heat-induced deformation and resulted conformal contact. **b**, Photograph of 4-inch graphene single-crystal transferred onto SiO_2/Si wafers. **c**, Typical transfer curves of as-transferred graphene after encapsulation by hBN and one-dimensional contacting at 300 K (navy blue) and at 4 K (red).