
Large-area transfer of two-dimensional materials free of cracks, contamination and wrinkles

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Abstract

Owing to its fascinating properties, graphene has exhibited great potentials in the applications of high-performance electronics and flexible devices. The availability of graphene films on a wide range of substrates forms the basis for graphene applications. For instance, the integration of graphene with silicon-based technologies, requires graphene on silicon-based substrate with outperforming carrier mobilities. Although large-area graphene films have been successfully produced based on chemical vapor deposition methods, graphene films were only produced on limited archetypal substrates, such as metal foils. Reliable after-growth transfer techniques are critical for layering 2D materials onto arbitrary substrates for further applications. During the transfer of graphene, polymer-based transfer medium is usually introduced for avoiding crack formation, which, however, introduces unavoidable contamination on graphene surface. Traditional transfer routes, including etching and bubble-based delamination, involve the aqueous solution-based reactions or processing, which would cause water-related doping in graphene and improve the complexity in the design of industrial equipment for batch transfer.

Here, we have achieved the crack, contamination and wrinkle-free transfer of graphene films over large area and designed transfer machines for automatic transfer with highly improved production capability: (1) we achieved “all-dry” transfer of graphene wafers, including the mechanical delamination of graphene from Cu surface and exfoliation of polymer from graphene surface, and all the transfer process were conducted without using water or organic solvent; (2) Transferred graphene wafers are free of cracks, contamination, and wrinkles, and the ultraclean surfaces provide the carrier mobilities of transferred graphene up to $14,000 \text{ cm}^2 \text{ V}^{-1} \text{ s}^{-1}$ at room temperature; (3) we designed and built the automatic transfer systems including automatic spin-coater, delaminator and laminator for the batch transfer of graphene films, enabling an improved production capability of 300 pieces (4-inch graphene wafer) per days.

References

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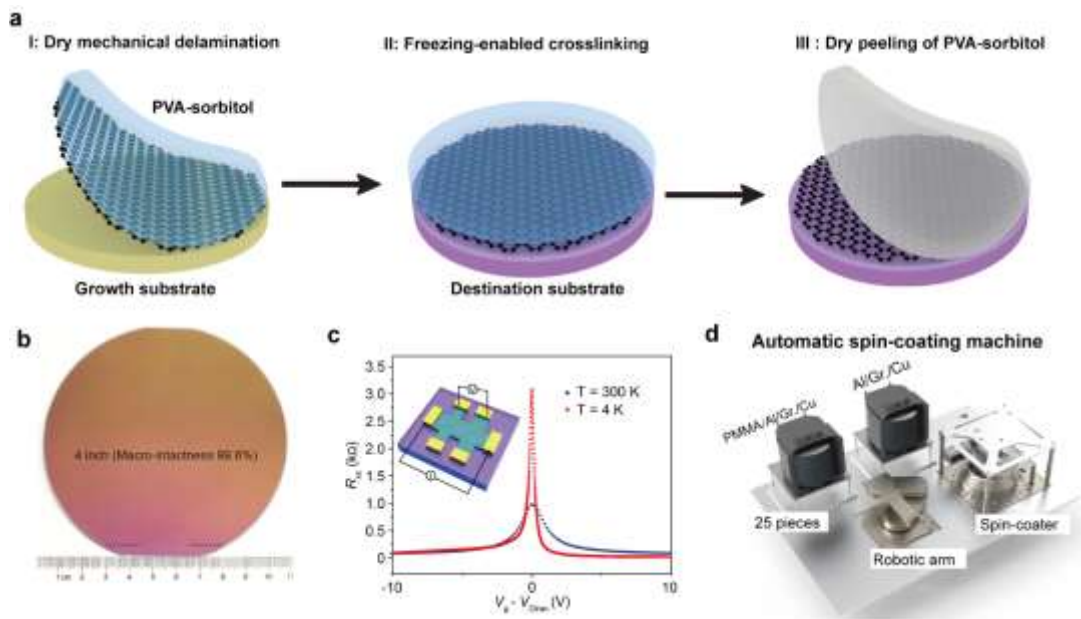


Figure 1: The crack, contamination and wrinkle-free transfer of large-area graphene films and automatic transfer systems.