# Defect-free 2D Materials Film Transfer Method

## Market Need

Graphene and other layered material such as boron nitride (BN) comprise two-dimensional sheets of atoms or ions bound together in which the effective thickness of the sheet is in the order of atomic or molecular thicknesses (usually less than 2 nm), which is far smaller than the lateral dimensions of the order of micrometers up to centimeters. These materials have numerous potential applications as the conductor, semiconductor or insulator in electronic, optoelectronic, optical, sensor and thermal devices, and for mechanical strength and toughness applications, for storage, or for surface-modifying applications including sensors. A key processing challenge to the development of a number of these practical applications however is the lack of a suitable method to pattern and transfer these films from their growth substrate to the target substrate, in a way that is reliable, robust, and suitable for manufacturing without damaging the properties of the transferred film. This is particularly challenging because the thin films are often in the single or few atomic sheet form, and are hence very fragile.

## Solution

Prof Peter Ho of the Department of Chemistry has invented a novel transfer method that provides a reliable, robust and manufacturable means to transfer fragile single-sheet graphene and other 2D film without fracturing it to any arbitrary substrate without depending on the competition of adhesive layer and target substrate to graphene. This is achieved by using a composite elastomeric (E) support layer together with a solvent-release (S) layer to receive the 2D film by dissolving away the first substrate that bears the 2D film. The E layer provides a semi-rigid support for the S layer which received the 2D film and so prevents its inadvertent stretching or deformation that causes micro-cracking and mechanical damage. This pick-and-place method will allow its applicability in organic semiconductor devices which is not possible using prior art methods. Figure 1 below shows Raman spectroscopy of a transferred graphene film on a 300 nm $SiO_2$ substrate at different locations of the substrate. The high quality of the transferred graphene film is evidenced from the low intensity of the D to G band (about 0.09), which is similar to that of the initially deposited graphene on the copper substrate by chemical vapour deposition (CVD).

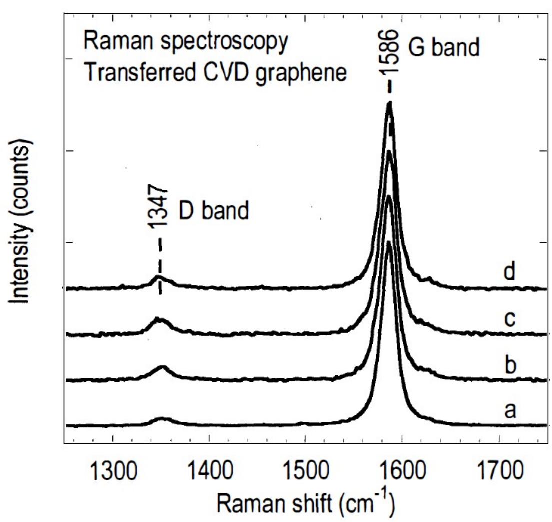


Figure 1: Raman spectroscopy of a transferred graphene film on a 300 nm $SiO_2$ substrate at different locations of the substrate. The low intensity of the D to G band (about 0.09) demonstrates the high quality of the transferred graphene film.

## Application and advantages

- Possible applications are in 2D materials film (eg. Graphene or Boron Nitride) transfer from growth substrate to target substrate
- Avoids the use of a carrier film which is susceptible to stress and strain (stretching, bending, warping) during mechanical manipulation.
- Does not rely on competition between adhesion to the substrate and adhesion to a first adherent layer, and so do not require any special preparation of the target substrate.
- No chemical etching is required to release the film, making it possible to use the method to transfer 2D films to all substrates.
- Allows for the option of patterning the 2D film being transferred by the addition of an oxygen plasma etching step before the growth substrate etching step.

## Keywords

2D materials film, graphene, boron nitride, transfer method

## ILO Reference:

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## Technology Readiness Level

TRL 3, material for testing, benchmarking, scalability testing.

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