



## Growing 2D and 3D graphene nano-structures on glass

Researchers report on a method for direct growth of 2D and 3D graphene nano-structures over large glass substrates using copper as a catalyst.

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Since its discovery, different techniques on how to grow high quality graphene over large planar area substrates have been investigated, developed and implemented. Among these techniques, processes like chemical vapor deposition (CVD) and plasma-enhanced CVD (PECVD) use transition metal foils that act as catalysts to favor the dissociation of a hydrocarbon gas. These processes have a major drawback; they require the transfer of graphene from the metal foils onto the desired substrate, in the process leaving organic residues on the substrate, reducing the performance and quality of the device.

In order to avoid contamination due to residue, research has been focused on direct growth on dielectric surfaces, using metal films as catalysts that can retract during growth, leaving the graphene on the dielectric area. Any additional residue would be removed using etching processes.

In a recent study published in *2D Materials*, ICFO researchers Miriam Marchena and Josep Canet Ferrer led by ICREA Prof. Valerio Pruneri at ICFO in collaboration with researchers from Corning and Cornell University of New York, report on the use of Copper (Cu) catalytic templates for the growth of graphene onto 2D- and 3D-G structures.

To demonstrate the versatility of their proposed technique, the team of researchers investigated the growth of three graphene structures with different optical, electrical and morphological properties, by properly defining the initial catalytic Cu templates. These graphene structures were: the arrangement of non-aggregated copper nanoparticles (Cu NPs) in different layers to produce the formation of a 3D-G sponge-like (3D-GS) structure; one layer of isolated Cu NPs to produce 3D-graphene nanoballs (3D-GB), and the aggregation of Cu NPs to form larger catalytic structures that produced 2D graphene (2D-G) networks.

The growth of the graphene onto the substrate was performed in three different steps. They first created a Cu patterning by dip-coating Copper-oxide particles on the substrate or by thermally evaporating the Cu from a Cu foil; then they grew the graphene by CVD methods and finally they removed any remaining Cu by wet etching, sublimation or both

In all, the synthesis of the graphene structures for all three scenarios was properly achieved. Even more, a very high optical transmission was maintained while also preserving electrical properties of the material, a very promising feature for applications such as transparent

electrodes and interfacial layers.

The results of this study are a major step forward towards the development of new surfaces that could be used for a wide variety of applications, such as antiglare display screens, solar cells, light-emitting diodes, and gas and biological plasmonic sensors, among others.