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NPL'S DEVICE PRODUCES HIGH-QUALITY, SINGLE-LAYER GRAPHENE

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We completed the development of the device and are ready to transfer the technology. Already a few research institutions in India have shown interest, says Bipin Kumar Gupta (right) | Photo Credit: Special arrangement

Researchers at Delhi's National Physical Laboratory (CSIR-NPL) have designed a low-pressure chemical vapour deposition (LPCVD) device that allows high quality, single-layer graphene measuring 4 inches in length and 2 inches in width to be grown. The quality of the single-layer graphene is metrology-grade, and can be used in next-generation quantum devices.

The thickness of a single layer is 0.34 nanometre and average grain size of graphene is 1-3 micrometre. Though there are about one billion grains in 4x2 square-inch single-layer graphene, the grains are highly connected to give a single continuous layer of graphene.

The LPCVD device developed indigenously costs about Rs.5,00,000, which is one-tenth of the imported ones. More importantly, the quality of the single-layer graphene grown using this device is superior than the ones reported in the literature. By growing single-layer graphene of high quality repeatedly for up to 30 times, the team led by Dr. Bipin Kumar Gupta from the Advanced Materials and Devices Metrology Division at NPL has demonstrated reproducibility. Results of the study were published in *ACS Omega.*

"It is possible to grow single-layer graphene measuring 6x4 square-inches but the quality will not be as good as when we grow graphene of smaller dimensions," says Dr. Gupta. This is because when attempts are made to grow larger graphene single layers, it is difficult to control the diffusion of carbon atoms which get deposited on the copper substrate. This compromises the quality of graphene single layer produced.

"We completed the development of the device and are ready to transfer the technology," says Dr. Gupta. "Already a few research institutions in India have shown interest." In fact, single-layer graphene grown by Dr. Gupta's team has been used for a specific study for quantum hall resistance metrology at Tata Institute of Fundamental Research (TIFR) in Mumbai and the results of the work have been analysed for further communication in scientific journal.

Generally, LPCVD devices have three mass flow meters through which hydrogen, argon and hydrocarbon gases are supplied to grow the graphene. Since the mass flow meters are expensive, Dr. Gupta's team replaced two such meters that supply argon and hydrocarbon with calibrated rotameters. "Unlike hydrogen, both argon and hydrocarbon have higher molecular weight and so it is easy to control the flow these gases. So we used calibrated rotameters as gas flow meters for these two gases," he says. The expensive mass flow meter is used only for hydrogen.

The graphene was grown on a substrate made of copper, which acts as a catalyst.

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