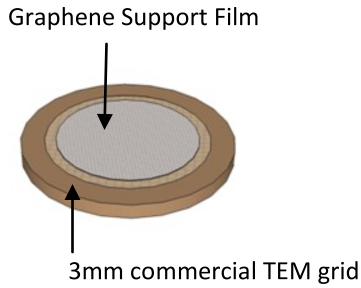
Graphene Transmission Electron Microscopy Support Films



Graphene Laboratories also specializes in custom orders. If your project requires a custom TEM grid we would be happy to assist you!

Specifications

- Graphene grown on Ni and transferred to a commercial TEM grid
- The graphene films are continuous and 1-6 monolayers thick
- We use polymer-free transfer methods to minimize graphene contamination
- Graphene coverage of TEM grids is 60-90%

In stock we have:

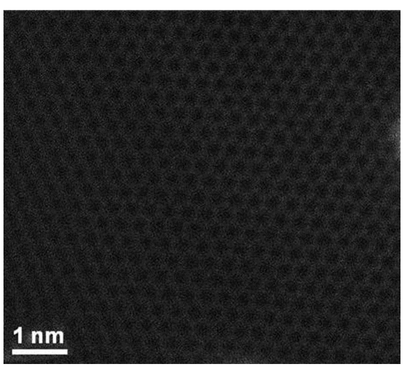
Graphene Film deposited on Lacey Carbon TEM grids, Copper 300 Mesh

- Lacey carbon is a carbon film consisting of woven mesh holes differing in size and shape

Graphene Film on Copper 2000 Mesh

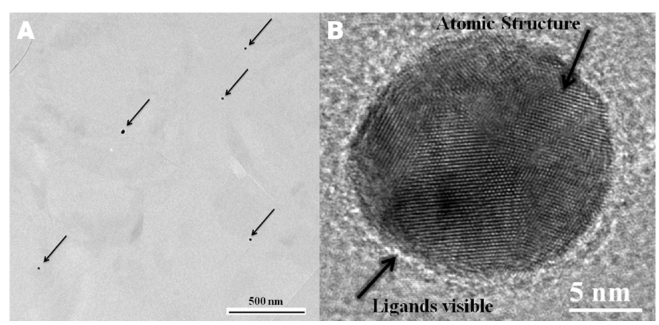
Graphene TEM Grids: A Hands-on Guide to Practical Applications

Transmission Electron Microscopy (TEM) is a technique which has proven indispensible in a range of scientific fields, including cancer research, materials science, virology, and semiconductor research. TEM, which has been around since 1931, allows users to examine specimen at a higher resolution than light microscopes. Grids are required to place specimen on, and traditional grids often have too large gaps for particularly small specimen, such as single atoms. Excitingly, graphene, a novel new nanomaterial, has found an application for use in TEM imaging. Graphene's properties, including its thinness, exceptional thermal and electrical conductivity, and strength, make it the perfect material to be used on these grids as a continuous support film. Because graphene is made of carbon atoms, it has a low atomic number (Z). The low atomic number reduces scattering of the electron beam, allowing for sharper images[1].



1. TEM image of high quality monolayer graphene from the Graphene Supermarket. Courtesy of Oak Ridge National Laboratory.

To use graphene in TEM imaging, high quality continuous graphene films are necessary. The R&D team at Graphene Laboratories has been working the past two years to optimize graphene films for use in TEM applications. Chemical vapor deposition (CVD) is well suited for making graphene used in TEM imaging. CVD is a process where the graphene is formed on a metallic film, usually copper or nickel, has been found to make high quality continuous films with high crystallinity as demonstrated by figure 1. The graphene forms after methane is introduced into the CVD furnace, then is heated to 1000°C so that it decomposes, leaving carbon atoms on the metal[2]. Then, the graphene must be isolated from the metal film to and transferred to a support substrate to be used for TEM imaging[1].



2. (A) Low resolution TEM image of gold nanoparticles with arrows pointing towards them on a graphene film. (B) A high resolution image of gold nanoparticles on a graphene film. The gold atomic structure and ligands are visible. The graphene films used were from the Graphene Supermarket, courtesy of Professor Bolotin, Vanderbilt University.

TEM images using graphene support films have a high contrast and low contamination level (See low resolution image, Fig 2A.) Deposited Au nanoparticles are clearly visible. Grids sold on the Graphene Supermarket use polymer-free transfer methods, thus are free of contamination. When viewed in high resolution, an atomically resolved image of the specimen is clearly visible (Fig 2B).

GRAPHENE SUPERMARKET®

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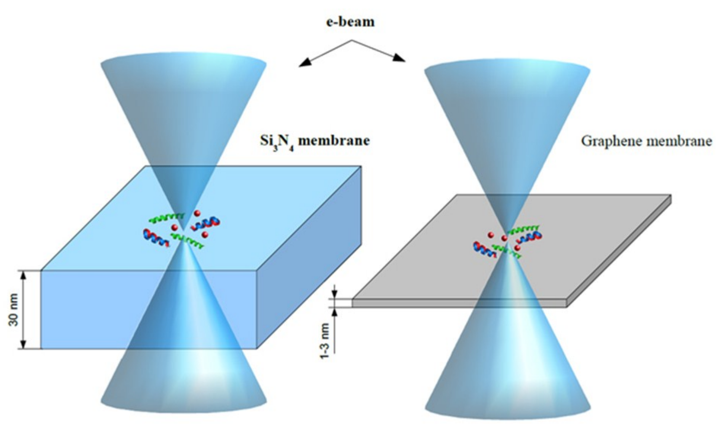


3. Thickness comparison of a silicon nitride TEM grid (left) to a graphene TEM grid (right).

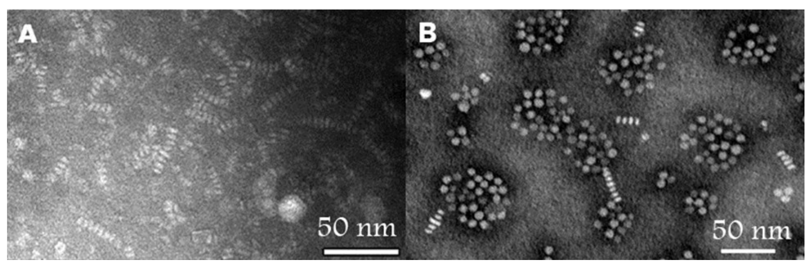
Conventional TEM grids can be made from many materials, including copper, nickel, aluminum, gold, and traditional amorphous carbon grids. When using these grids to image biological samples, the sample often attaches to the walls of holes in the grids. This can be problematic, and is resolvable by using a thin, continuous film as a TEM support. Silicon nitride is available as a film for TEM imaging because it is continuous, however, it is much thicker than graphene[3].

Graphene, only a single or a few atomic-layers thick, is a much better choice of film for TEM grids than silicon nitride, as demonstrated by Fig 3. Its thinness makes it nearly transparent to the electron beam used for TEM imaging, and its strength allows it to stay intact and support samples despite it being atomically thin.

The improved quality of graphene TEM grids also eliminates the need for negative staining of biological specimen with heavy and radioactive salts when doing Cryogenic TEM (cryoTEM). Negative staining can make it difficult to get an accurate representation of a specimen because it is diluted by the salts. Eliminating negative staining will greatly improve the fundamental understanding of biological processes, reduce the cost of drug development, and facilitate clinical diagnostics.

In cryoTEM, a biological sample is immobilized on a microscope grid. Immediately, it is submerged into a cryogenic liquid; liquid ethane is the most commonly used agent. CryoTEM requires extreme temperatures, and because graphene is so robust it is able to endure these temperatures.

Graphene TEM grids are used successfully, as exemplified by Nair et al when imaging tobacco mosaic viruses (TMV). Though for Nair's group there was contamination when transferring graphene from a metallic film to the TEM grid, the images were still extraordinarily sharp when compared to traditional TEM grids. This was able to be achieved because graphene has very weak adsorption properties; even with some contamination, the contrast was still higher than that of an amorphous carbon film[4].



4. TEM image of discoidal high density lipoproteins on a conventional TEM grid (A) when compared to a graphene TEM grid from the Graphene Supermarket (B). Courtesy of Professor Bolotin and Professor Jerome, Vanderbilt University.

TEM grids produced by Graphene Supermarket have been demonstrated to be high-quality supports for biological and other specimen.

When compared to a conventional TEM grid, the images are much more sharp and detailed, making them especially useful for various biological applications. Graphene has a crucial role in TEM imaging, and biologists are sure to find these new grids invaluable.

References

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