Dispersion of Graphene Nanoplatelets

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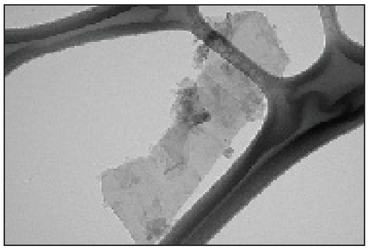
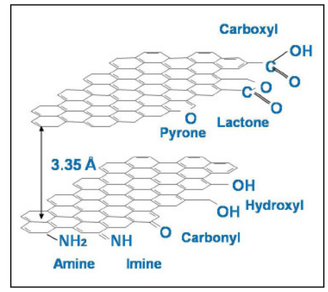


TEM Image of nearly transparent platelet - 750 m^2/g

Graphene nanoplatelets with an average thickness of the 5–10 nanometers are offered in varying sizes up to 50 microns. They are comprised of short stacks of platelet-shaped graphene sheets that are identical to those found in the walls of carbon nanotubes, but in a planar form.



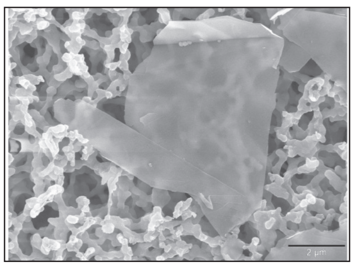
Graphene nanoplatelets are 6-8 nm thick with a bulk density of 0.03 to 0.1 g/cc, an oxygen content of <1%, a carbon content of >99.5 wt%, and a residual acid content of <0.5 wt%, and are offered as black granules.

Graphene nanoplatelet aggregates are aggregates of sub-micron platelets with a diameter of <2 microns, a thickness of a few nm, a bulk 0.2 to 0.4 g/cc, an oxygen content of <2 wt%, and a carbon content of >98 wt%, and are offered as black granules or a black powder.

Dispersion: General Information

Like other nanoscale materials, special handling is required for *graphene nanoplatelets*. While they are supplied in granular form, they must be fully dispersed in order to exhibit their optimal properties.

It is important to note that effective dispersion depends not only on the size of the *graphene nanoplatelets*, but also the choice of medium, the energy used for dispersion, and the time allowed. In general, smaller *graphene nanoplatelets* are dispersed more effectively than larger particles, lower viscosity matrices provide better results, and surface treatment can positively influence dispersion in some resin systems.



The use of surfactants will improve the stability of suspensions of *graphene nanoplatelets*. However, upon storage, suspensions will settle unless frozen.

Graphene nanoplatelets cannot be dispersed any further once the minimal electrical resistance of the suspension has been reached. The electrical resistance can be measured using a probe prepared by stripping ~1/2 inch of each end of a section of residential 12 gauge ROMEX wire and cutting off the ground wire. The resistance of the suspension can be read by connecting one end of the wire to a resistance multimeter and placing the other in the suspension.

Dispersion into Specific Media

- **Non-aqueous solvents:** N-methylpyrrolidone (NMP), dimethylformamide (DMF), tetrahydrofuran (THF), toluene, ethyl acetate, isopropanol, ethanol, acetone, methyl ethyl ketone (MEK), chloroform, 2-aminobutane, and other polar solvents. Preferred method of dispersion: probe sonication for non-viscous liquids; high shear mechanical mixing for viscous liquids.
- **Aqueous systems:** pH of 7-9; dispersing aids (sodium dodecylbenzene sulfonate, poly(sodium styrene sulfonate), polyoxyethylene octyl phenyl ether, etc.) can be used; Method: probe sonication or high shear mixing. Note that, typically, completely settled particles can be re-disperse with high energy mixing, while those that have settled for only a short period can be re-dispersed with shaking.
- **Thermoplastic matrices:** Pre-mixing is recommended, and preferably with powdered polymers rather than pellets. Lower melt viscosity resins (determined by choice of polymer or obtained through the use of a higher process temperature) provide better dispersions. Experimentation with the extrusion process is often necessary, although counter-rotating screws are often effective.
- **Thermoset resins:** It is important to slowly add the *graphene nanoplatelets* to the resin. High shear mixing or sonication of the *graphene platelets* directly into the matrix is possible for low viscosity resins, while heat, sometimes combined with use of a high shear in-line dispenser, may be necessary for high viscosity matrices. Note, however, that extended high shear mixing can damage the platelets.

Strem Graphene Nanoplatelets

06-0210: Graphene nanoplatelets (6-8 nm thick x 5 microns wide)
06-0215: Graphene nanoplatelets (6-8 nm thick x 15 microns wide)
06-0220: Graphene nanoplatelets (6-8 nm thick x 25 microns wide)
06-0225: Graphene nanoplatelets aggregates (sub-micron particles, surface area 300m^2/g)
06-0230: Graphene nanoplatelets aggregates (sub-micron particles, surface area 500m^2/g)
06-0235: Graphene nanoplatelets aggregates (sub-micron particles, surface area 750m^2/g)

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