XG sciences

Multifunctional Nanomaterials

# xGnP® Graphene Nanoplatelets

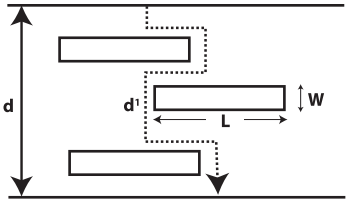
*Carbon Nanoparticles with Multifunctional Capability*

## Reducing Permeability with xGnP® Nanoplatelets

When compounded into a polymer film or solid part, **xGnP®** *graphene nanoplatelets* significantly reduce the *Permeability* or *Diffusion Coefficients* of the matrix material. This reduction in permeability is a function of the platelet morphology of **xGnP®** *nanoplatelets*, since it increases the *Tortuosity Factor* of a permeant – literally making a gaseous molecule's escape path through the composite material a "long and winding road." The high *aspect ratio* of the platelets – which are far wider than they are thick – makes them effective at low loading levels, which helps reduce cost and impact on other properties. Laboratory tests with nylon and other thermoplastic resins show several-orders-of-magnitude improvements in permeability when compounded with **xGnP®** *nanoplatelets*.

Permeability is significantly influenced by the particle size of the additive, so we make **xGnP®** *nanoplatelets* available in sizes ranging from 1 to 100 µm in diameter. In general, larger diameter particles provide greater reductions in permeability. In laboratory tests, 15-µm particles compare favorably with most nanoclays and clearly outperform other carbon-based materials.

### Effect of Platelet Size and Concentration on Permeability




**Total path of a diffusing gas**

$d^1 = d + d*L*Vf / 2W$

d: thickness of a film
L: length of a platelet
W: width of a platelet
Vf: volume fraction of platelets

**Tortuosity factor**

$t = d^1 / d$
$= 1 + L*Vf / 2W$

**Equation for a permeability coefficient**

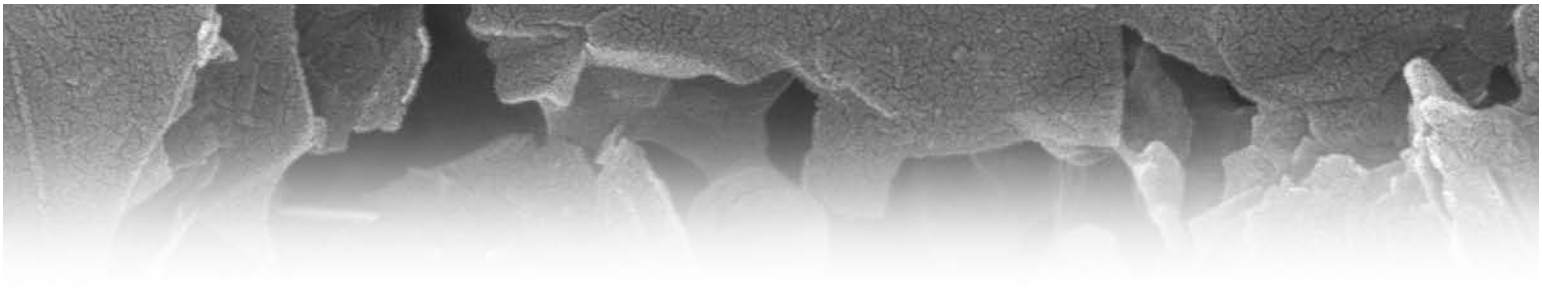
$Pc = Pp / t$
$= Pp / (1+L*Vf / 2W)$

Pp: permeability coefficient of a matrix polymer

## Multifunctional Property Improvements

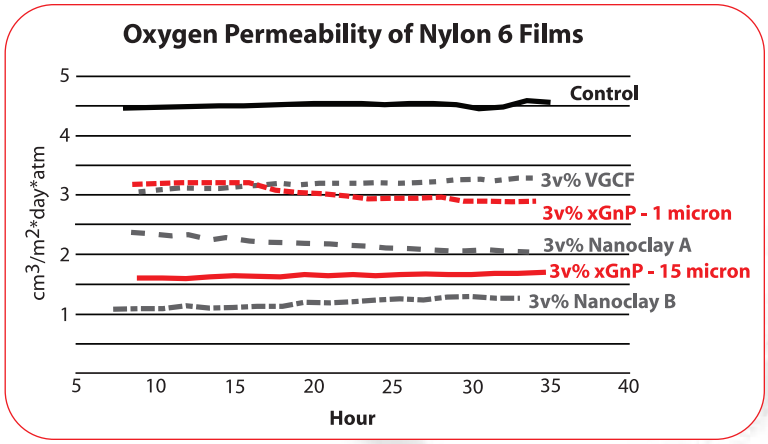
Unlike nanoclays, **xGnP®** *nanoplatelets* also provide inherent electrical conductivity for dissipation of static electricity, making them highly useful for barrier applications involving flammable gases or liquids, such as automotive fuel tanks and fuel-line components. And unlike other barrier additives, *nanoplatelets* enhance mechanical properties like stiffness, strength, and scratch-resistance without reducing toughness (impact strength). They also improve thermal stability and thermal conductivity.

These *multifunctional property improvements* make **xGnP®** *graphene nanoplatelets* an ideal additive for barrier applications where reduced permeability coupled with other property improvements offer the opportunity for significant processing or material cost savings by reducing or eliminating the need for multiple films or expensive lamination processes.



## About xGnP® Nanoplatelets

**xGnP®** *graphene nanoplatelets* are unique particles consisting of very-thin platelets of crystalline graphite. Typical particles of **xGnP®** *nanoplatelets* consist of stacks of one or more graphene sheets, which form a *platelet*. Each *platelet* is typically 2 – 10-nm thick and its diameter – a feature that we control – can range from submicron to 100 µm in size. The graphene sheet that forms the basal plane of these platelets is identical in composition to the graphene wall of a carbon nanotube only in a flat sheet form. Edges of the platelets are the sites for functionalization, which helps facilitate hydrogen or covalent bonding within a polymer matrix.




The unique size and platelet morphology of **xGnP®** *nanoplatelets* makes these particles especially effective at providing barrier properties, while their pure graphitic composition makes them excellent thermal and electrical conductors. Unlike many other additives, **xGnP®** *nanoplatelets* improve mechanical properties such as stiffness, strength, and surface hardness of the matrix material. **xGnP®** *nanoplatelets* are compatible with almost all polymers and are available in a range of masterbatch compositions.

## Our Competitive Pricing Advantages

The unique price and performance properties of **xGnP®** *nanoplatelets* allow them to be cost-competitive in many applications where a combination of property improvements is required. Ease of processing and broad compatibility with many different polymer systems make this material a natural choice for high-performance barrier applications.

## To Learn More

For more information on **xGnP®** *nanoplatelets* and the products made with them, please contact us at:

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