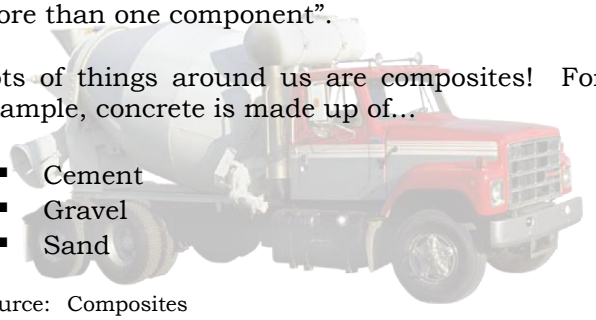
Nanocomposites: Coming Soon to a Store Near You

Nanotechnology is all about being small. After all, the prefix "nano" means one billionth of something. For example, a nanometer is a billionth of a meter. The word "nanotechnology" usually makes people think of science fiction movies: fancy futuristic gadgets, tiny little robots, and other amazing things that we can only dream about. Practically speaking, nanotechnology is about manipulating materials on the molecular or the atomic level to give them new properties and functions. For example, nanocomposites are a new kind of material that combine plastic and nano-sized fibers of clay. Nanocomposites have many advantages over regular plastic, and have started showing up in products you can buy. We may not be able to make science fiction into reality just yet, but all this focus on the small stuff is becoming a very big deal.

What is a Composite?

A composite is "any material that is made up of more than one component".



Lots of things around us are composites! For example, concrete is made up of…

- Cement
- Gravel
- Sand

Source: Composites
http://www.psrc.usm.edu/macrog/composit.htm

The next time you look at a car, you could be looking at nanotechnology without even realizing it. For the past several years, car companies have been using nanocomposites instead of plastic to make certain car parts. In 2001, Toyota started using nanocomposites to make bumpers for their cars. In 2002, General Motors (GM) made nanocomposite "step-assists" – external running boards that help people get into and out of cars – an option on the 2002 Chevrolet Astro and the GMC Safari. [1]

Nanocomposites are lighter, stiffer, less brittle, and more dent- and scratch-resistant than conventional plastics. Some nanocomposites are also more recyclable, more flame retardant, less porous, better conductors of electricity, and can be painted more easily. [2, 3]

Small Additions, Big Changes

A conventional plastic is a composite made up of two components: the matrix, and the filler. To get an idea of how this works, picture a different kind of composition: a block of concrete that has steel rods running through it. In this example, the concrete is the matrix and the steel rods are the filler. The steel rods make the composite stronger and more resistant to stress. The concrete hold the steel rods together.

How are Plastics Made?

Plastics have two components which work together to make a plastic strong, but not brittle.

Matrix
- Holds the filler together
- Absorbs energy when under stress

Filler
- Adds strength
- Reduces the weight of the matrix

Source: Composites
http://www.psrc.usm.edu/macrog/composit.htm

Conventional plastics can use a lot of different materials for the matrix, such as resin or nylon. Large particles of talc and glass are usually used as filler. However, talc and glass filler can make a plastic dense and brittle, and can make clear plastics look cloudy. In addition, the amount (15-20% of the total volume) needed and large size of the particles needed makes it difficult to make a smooth plastic. [2] We can solve these problems and make a longer-lasting, more versatile plastic by using nanoparticles of clay as filler instead.

[1] Adding even a small volume of nano-filler can make a plastic more resistant to wear-and-tear and breakage without affecting the surface quality or the transparency.

How a nanocomposite behaves depends entirely on the size of the clay fibers added. The smaller and thinner the fibers, the more surface area is available to interact with the plastic matrix, and the more improvement we see in the plastic. The clay fibers used can be as little as one nanometer thick and 100-1000 nanometers long. [1] A number of different nanocomposites have already been developed using matrices of nylon, resin, or a type of plastic called a polyolefin. Most of these nanocomposites use nanoparticles of smectite, a pure type of clay, as the filler. [3] More advanced fillers are being developed now, such as long tubes of carbon atoms called "carbon nanotubes". In a few years, these new fillers will make nanocomposites even stronger and better than they are now. [2]

Early research and development of uses for nanocomposites was made difficult by high costs of the clay nano-filler. [2] However, now nanocomposites can be made for almost the same price as conventional plastics. The size of the clay fibers has grown even smaller, which means that even tiny amounts of filler (2% of the total volume) can be added to achieve the same effects. [3] In addition, plastics manufacturers can make nanocomposites using the same molds they use for other plastics to help save money. [2] This has led an explosion in the number of ways you might see a nanocomposite used.

Nanotechnology in Your Car

Now that we know a little about nanocomposites, why would car makers like Toyota or GM want to use them in their cars instead of regular plastic? In addition to being stronger and longer-lasting than conventional plastics, nanocomposites also have a very important advantage: they are lighter. It's important for a car to be as light as possible. Lighter cars use less gasoline, which means that they are less expensive for people to own.

Taking Nanocomposites for a Ride

GM uses a specific type of nanocomposite in its cars called a **thermoplastic olefin** (TPO) – based nanocomposite. What does that mean?

- **Thermoplastic:** a material that melts when heated
- **Olefin:** a chemical which has a molecular structure with two carbon atoms doubly bonded together

Source: Thermoplastics
http://www.psrc.usm.edu/macrog/plastic.htm

The new bumpers that Toyota has been making for its cars are 60% lighter than the old plastic bumpers and twice as hard to scratch or dent. [4] According to GM, the nanocomposite step-assists are 7-8% lighter than the old step-assists and have more strength and better surface quality. GM is now testing how nanocomposites might be used in other car parts, like in the panels that make up the body of the car or in the panels that support the doors and passenger compartment. [3]

Complete Package

The advantages of nanocomposites over conventional plastics don't stop at strength. The high heat resistance and low flammability of some nanocomposites also make them good choices to use as insulators and wire coverings. Another important property of nanocomposites is that they are less porous than regular plastics, making them ideal to use in the packaging of foods and drinks, vacuum packs, and to protect medical instruments, film, and other products from outside contamination. [2]

Think about all the objects in the world that are made of plastic or have plastic components. We use plastic objects in nearly every part of our lives. How might the properties of nanocomposites, such as increased durability, strength, or recyclability, affect these objects? Nanocomposites may not seem like the fancy nanotechnology we see in movies and on TV, but they have the potential to change the way we do things in every way.

References

[1] The Future of Automotive Plastics. *PR Newswire.* Accessed April 30, 2003. URL: http://www.scprod.com/gm.html

[2] Leaversuch, R. Nanocomposites Broaden Roles in Automotive, Barrier Packaging. *Plastics Technology Online*. Accessed April 30, 2003. URL: http://www.plasticstechnology.com/articles/200110fa3.html

[3] Buchholz, K. Nanocomposite debuts on GM vehicles. *Automotive Engineering International Online.* Accessed April 30, 2003. URL: http://www.sae.org/automag/material/10-2001/index.htm

[4] Current Nanotechnology Applications. *Nanotechnology Now.* Accessed May 1, 2003. URL: http://nanotech-now.com/current-uses.htm