Polystrene

Polystyrene is an inexpensive and hard [plastic](http://pslc.ws/plastic.htm), and probably only [polyethylene](http://pslc.ws/pe.htm) is more common in your everyday life. The outside housing of the computer you are using now is probably made of polystyrene. Model cars and airplanes are made from polystyrene, and it also is made in the form of foam packaging and insulation (StyrofoamTM is one brand of polystyrene foam). Clear plastic drinking cups are made of polystyrene. So are a lot of the molded parts on the inside of your car, like the radio knobs. Polystyrene is also used in toys, and the housings of things like hairdryers, computers, and kitchen appliances.

Polystyrene is a [vinyl polymer](http://pslc.ws/vinyl.htm). Structurally, it is a long hydrocarbon chain, with a phenyl group attached to every other carbon atom. Polystyrene is produced by [free radical vinyl polymerization](http://pslc.ws/radical.htm), from the monomer styrene.

Polystyrene is also a component of a type of hard rubber called [poly(styrene-butadiene-styrene)](http://pslc.ws/sbs.htm), or SBS rubber. SBS rubber is a [thermoplastic elastomer](http://pslc.ws/tpe.htm)

The Polystyrene of the Future

There's a new kind of polystyrene out there, called [syndiotactic](http://pslc.ws/tact.htm) polystyrene. It's different because the phenyl groups on the polymer chain are attached to alternating sides of the polymer backbone chain. "Normal" or [atactic](http://pslc.ws/tact.htm) polystyrene has no order with regard to the side of the chain on which the phenyl groups are attached.

But there are still some fun things you can do with old fashioned atactic polystyrene. Wanna see something really nift-o-matic?

What would happen if we were to take some styrene monomer, and polymerize it free radically, but let's say we put some [polybutadiene](http://pslc.ws/pb.htm) rubber in the mix. Take a look at polybutadiene, and you'll see that it has double bonds in it that can polymerize. We end up with the polybutadiene [copolymerizing](http://pslc.ws/copoly.htm) with the styrene monomer, to get a type of copolymer called a [graft copolymer](http://pslc.ws/copoly.htm#graft). This is a polymer with polymer chains growing out of it, and which are a different kind of polymer than the backbone chain. In this case, it's a polystyrene chain with chains of polybutadiene growing out of it.

These rubbery chains hanging off of the backbone chain do some good things for polystyrene. Polybutadiene and polystyrene homopolymers don't mix, mind you. So the polybutadiene branches try as best they can to phase separate, and form little globs, like you see in the picture below. But these little globs are always going to be tied to the polystyrene phase. So they have an effect on that polystyrene. They act to absorb energy when the polymer gets hit with something. They give the polymer a resilience that normal polystyrene doesn't have. This makes it stronger, not as brittle, and capable of taking harder impacts without breaking than regular polystyrene. This material is called *high-impact polystyrene*, or HIPS for short.

I'll let you in on a little secret. Not all the chains in HIPS are branched like this. There are a lot chains of plain polystyrene and plain polybutadiene mixed in there, too. This makes HIPS something we call an [immiscible blend](http://pslc.ws/iblend.htm) of polystyrene and polybutadiene. But it is the grafted polystyrene-polybutadiene molecules that make the whole system work by binding the two phases (the polystyrene phase and the polybutadiene phase) together.