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(Un)Stuck On You

By Renée Heiss

Isn't it embarrassing when your pants or skirt cling to every curve of your body? Or when you fold laundry, and clothes are stuck to each other, making it harder to find small items such as socks. And if you have pets—especially white cats or dogs—their hair will always stick to your black pants. What most people do is use a fabric softener when they wash their clothes, but this solution is temporary because once the fabric softener rubs off, the clothes start clinging again.

In the near future, clothing could be made with a fabric that removes static cling, making such clothes “static-free.” Dresses and pants made with this fabric would not cling to your body anymore, and when they are washed, they would not bind to other clothes. This fabric would contain nanoparticles—very small particles that have amazing properties and hold promise for a variety of applications, such as drug delivery, medical imaging, and house-cleaning products.

What is static cling?

Before taking a look at these static-free clothes, let's see why static cling occurs in the first place. You probably had firsthand experience with static electricity when you received an electric shock after turning a doorknob or when you pulled your bed covers up and they made sparks. But while these effects of static electricity can be experienced by anyone, the cause of static electricity is not as obvious. That's because it is happening at the atomic level.

As you know, many materials are made of atoms that are electrically neutral because they contain equal numbers of positive charges (protons in their nuclei) and negative charges (electrons surrounding the nucleus). But when two materials are in contact, sometimes electrons move from one material to the other, especially when one of the materials has weakly bound electrons—and tends to lose them—and the other material has sparsely filled valence shells and tends to gain electrons. Then, when the materials are separated, one of them keeps the extra electrons and is negatively charged and the other is positively charged because it lost electrons. This is known as the triboelectric effect.

An antistatic agent, such as fabric softener, reduces or eliminates buildup of static electricity by attracting water molecules to the surface of fabrics. The molecules of an antistatic agent often have both a hydrophobic side, which repels water molecules,



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Static cling makes your clothes stick to your body (left). Using fabric softener or wearing clothes made with nanotextiles eliminates static cling (right).



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A Naturally Static-Resistant Fabric

Are there naturally static-resistant textiles? Of all the fibers, both natural and synthetic, the answer would be wool because it absorbs water more readily than any other fiber. It can store water vapor up to 35% of its own dry weight yet it remains dry to touch, which makes it the perfect choice for hikers' socks. The water vapor surrounding the wool acts like nanotextiles with their thin layer of atoms. Wool also behaves like a garment that has been treated with fabric softener. Wool is nature's own static-resistant fiber, but it is not static-proof like nanotextiles.

and a hydrophilic side, which attracts water molecules. The hydrophobic side interacts with the surface of the fabric, while the hydrophilic side interacts with the water molecules present in air moisture. Because the water molecules are polar, they bind to the electric charges on the surface of the fabrics and attenuate their attraction to oppositely charged particles, thus reducing static cling.

Fabric softeners also lubricate clothing—this is actually their primary role—which significantly reduces friction between different pieces of clothing and reduces the chances that they will be in contact with each other and exchange electrons. Also, because fabric softeners attract water molecules in the air, the water-coated fibers in clothes slide alongside each other without friction, which is another reason electrons are not released and static cling does not occur.

Unfortunately, fabric softeners eliminate static cling only temporarily. As a fabric softener naturally rubs off a fabric through everyday use, the clothes' fibers become susceptible to static cling again.

Nanotextiles

To eliminate static cling more permanently, garment manufacturers have tried to coat fabrics with an antistatic finish during the manufacturing process. This way, clothes are already coated with an antistatic substance that stays on them for a long time—if not forever. Unfortunately, this type of cloth material feels stiff, and the coating process clogs the weave, making the fabric impermeable to air. When that happens, it does not wick away perspiration, and people feel cold and clammy.

So, what's next? Garment manufacturers decided to apply antistatic substances directly to the fibers that make up clothes. Fibers are the smallest visible unit of any textile product. They are long, thin strands of material that are spun into yarn and made into fabrics. They can be natural—such as cotton, silk, and wool—or synthetic, such as polyester, acrylic, and nylon.

The idea of applying antistatic substances to individual fibers at the molecular level

may have seemed far-fetched at the time (in the 1950s), but it worked! It took decades of experimentation until garment manufacturers were able to find an antistatic substance called a carbon nanotube. Clothing items made with this substance are not only static-free, but they are also comfortable to wear, and the fabric is neither bulky nor clammy.

A carbon nanotube is a cylindrical carbon molecule formed by one sheet of graphite rolled up into a cylinder. Carbon nanotubes have unusual strength because every carbon atom is connected to three other carbon atoms, which makes a very strong bond.

Triboelectric Effect

Materials with sparsely filled valence shells tend to gain electrons, while materials with weakly bound electrons tend to lose them. This is known as the triboelectric effect and results in one material becoming positively charged and the other negatively charged.

The relative attraction for electrons of various substances has been studied experimentally. This led to a table called the triboelectric series, which compares the strength of electric charges on various materials once they are separated (Table 1).

The triboelectric effect is the main cause of static electricity. Charge separation causes your hair to stand up and causes clothes to stick to one another after they are washed.

Tend to lose electrons ↑ ↓ Tend to gain electrons	(+)
	human hands (dry)
	glass
	human hair
	nylon
	cat fur
	silk
	cotton
	steel
	wood
	amber
	ebonite
	plastic wrap
	Teflon®
	(-)

Table 1. Triboelectric series

When carbon nanotubes are used with natural fibers, they form a strong, tightly bonded coating on each fiber. The fibers are then made into yarns that are woven into fabrics. Because the nanotubes easily slip past each other, the fabric feels soft, and the lack of friction also results in a lack of static discharge.

Although scientists and garment manufacturers are still experimenting with such fabrics, clothes made with nanoparticles—aggregates of atoms that have less than 100 nanometers in diameter—are commercially available. These clothes, called nanotextiles, include waterproof clothing, stain-proof cloth seats, and lightweight sportswear.



pants, dress, or jacket, and see if you find any reference to nanotextiles. You might be surprised at how well it keeps you warm when it is cold out and repels water when it rains! **CM**

SELECTED REFERENCES

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