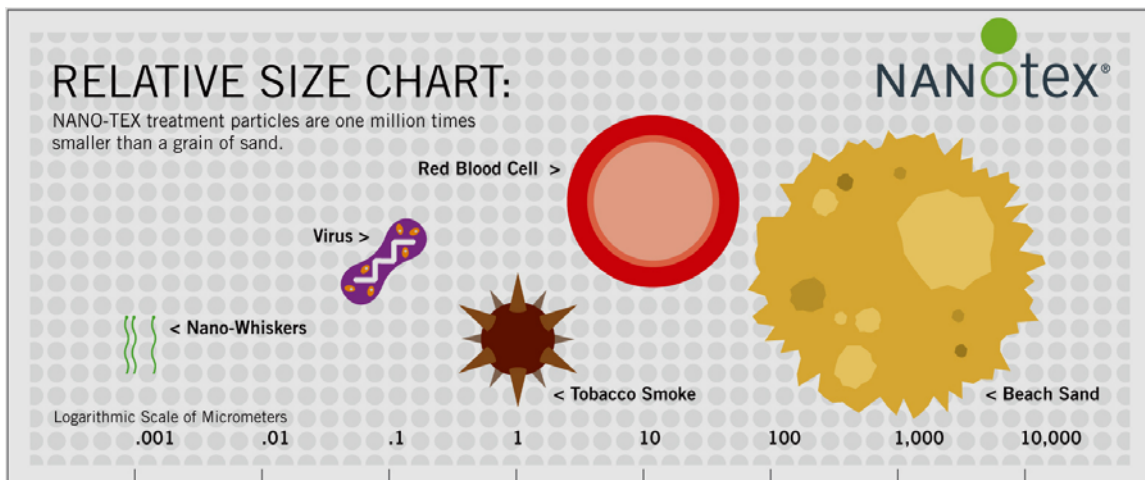


Nanofibers on Your Clothes

Background:

Nanotechnology is the manipulation of matter, atom by atom at the “nanoscale.” A nanometer is 1 billionth (1×10^{-9}) of a meter – about 3 to 5 atoms (depending on which kind of atoms) wide. In 1998, David Soane founded Nano-Tex, a company created to find ways to improve the strength, durability and usefulness of natural fibers such as cotton and wool, that we use to make clothing. Sloane developed a way to bond nanotubes, tiny structures he called “nanowhiskers” to each individual thread of the cloth. Nanotubes are made of carbon and are only about 10 nanometers long, each. The “nanowhiskers” are so small and so close together, they form a sort of barrier around each fiber of the cloth that prevents liquids and other substances that stain fabric from even touching the actual fabric. Instead, liquids bead up and can be brushed off like loose dirt. The relative size of the nanowhiskers to the cotton or wool thread can be compared to the relative size of peach fuzz on a lamp post. The nanofibers cannot be seen or felt on the cloth, so it feels as soft as any untreated cloth. The relative size of nanofibers is shown below:



Before the development of “nanowhiskers” fabric manufacturers used various perfluoro aliphatic compounds, waxes, other polymers and an aluminum or zirconium salt to carry the compounds to the fabric. These compounds are very good at repelling water, and research and development over the years has made these treatments cost effective and durable. The size and weight of these molecules however, are significantly larger than nanofibers and can make treated fabrics feel heavy or stiff. Their large size also causes light rays to scatter, causing a slight change in color to treated fabrics. While this is fine on outdoor clothing, they are not practical for everyday, normal wear such as pants, shirts or dresses. Also, polymers merely coat the fabric and wear off after several times through the laundry or dry cleaning.

Purpose:

The purpose of this activity is to compare the weight, and “feel” of nanofiber treated fabrics to both untreated and Scotchguard® treated fabrics, as well as their susceptibility to stains from various sources.

Materials:

Samples of treated and untreated fabric, about 7 cm square or small enough to fit in a petri dish

Samples of typical staining substances:

Grape juice, tomato sauce, vegetable oil, soy sauce, grass stain and lipstick.

Eyedroppers for each substance.

Plastic Petri dishes

Paper towels

A clean, white, cloth towel.

Liquid laundry detergent

Procedure:

1. Place each fabric sample in a separate Petri dish, and label the dish accordingly
2. Using a thin tip permanent marker, divide the fabric samples into 4 equal areas of about 4 cm² each.
3. On the Petri dish bottom, label the substance to be applied to each area.
4. Apply about 4 drops of each chemical to each sample and briefly describe what happens in the spaces provided on the data page.
5. Dab the stain with a paper towel and briefly describe what happens in the spaces provided in Table I.
6. To test the grass stain, take about 10 blades of grass and rub them on the section of cloth. Record your observations in the space provided on the data page.
7. Wet the clean white cloth towel and apply 3 drops of liquid laundry detergent. Gently rub one of the stains. Repeat this procedure with different sections of the cloth so that each stain is rubbed with a clean section of cloth. Record your observations.

Data Page

Observations of Staining Substances on Treated and Untreated Cloth Samples

Untreated Khaki

	Staining Substance	Initial appearance	After Dabbing with a Paper Towel	After treatment with Detergent
1				
2				
3				
4				
5				
6				
7				
8				

Observations of Staining Substances on Treated and Untreated Cloth Samples

Scotchguard® treated khaki

	Staining Substance	Initial appearance	After Dabbing with a Paper Towel	After treatment with Detergent
1				
2				
3				
4				
5				
6				
7				
8				

Observations of Staining Substances on Treated and Untreated Cloth Samples

Nano-Whiskered Khaki

	Staining Substance	Initial appearance	After Dabbing with a Paper Towel	After treatment with Detergent
1				
2				
3				
4				
5				
6				
7				
8				

Questions:

Nanofibers are typically about 1.5 nanometers in diameter, about 10 nanometers long and made of carbon atoms. Waxes and perflouro aliphatic compounds are very long chain polymers of hundreds of carbon atoms combined with other atoms such as fluorine and oxygen.

1. Was there a noticeable difference in feel or texture between the untreated fabric and the nanofabric?
2. Was there a noticeable difference feel or texture between the polymer treated fabric and the untreated fabric?
3. What is an advantage of using polymer treatments to stain proof clothing?
4. What are the advantages of using nanofiber-treated fabrics for clothing?
5. Which fabric was the most susceptible to permanent staining?
6. Which fabric was least susceptible to permanent staining?
7. Were there any staining substances that were damaging to all fabric types?

Insight: _____

