Invisible Sunblock

One of the most common applications of nanotechnology is the use of nanoparticles in sunblock, yet most consumers don't know about it! Explore the use of nano-scale particles in mineral sunblock to increase its transparency and discover the difference between sunscreen and sunblock in this hands-on activity.

TEKS:

3.5D Explore and recognize that a mixture is created when two materials are combined, such as gravel and sand, or metal and plastic paper clips.

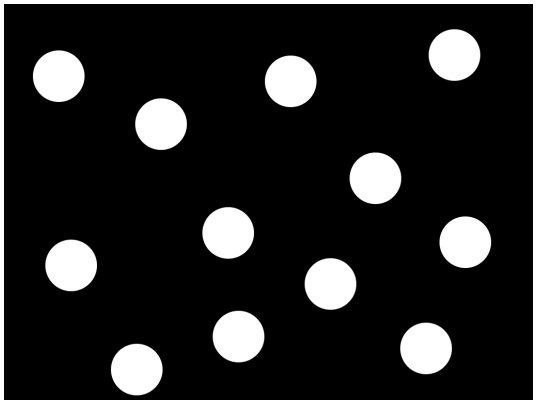
4.5AC Compare and contrast a variety of mixtures and solutions such as rocks in sand, sand in water, or sugar in water.

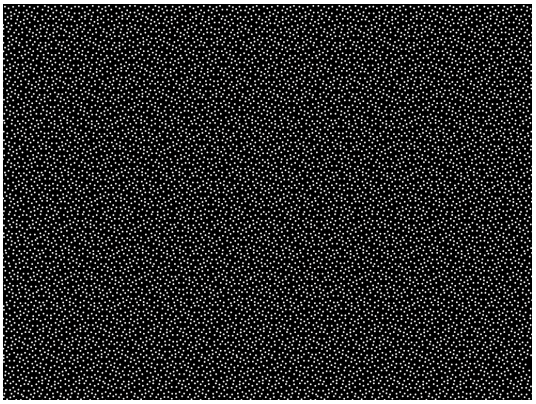
Materials:

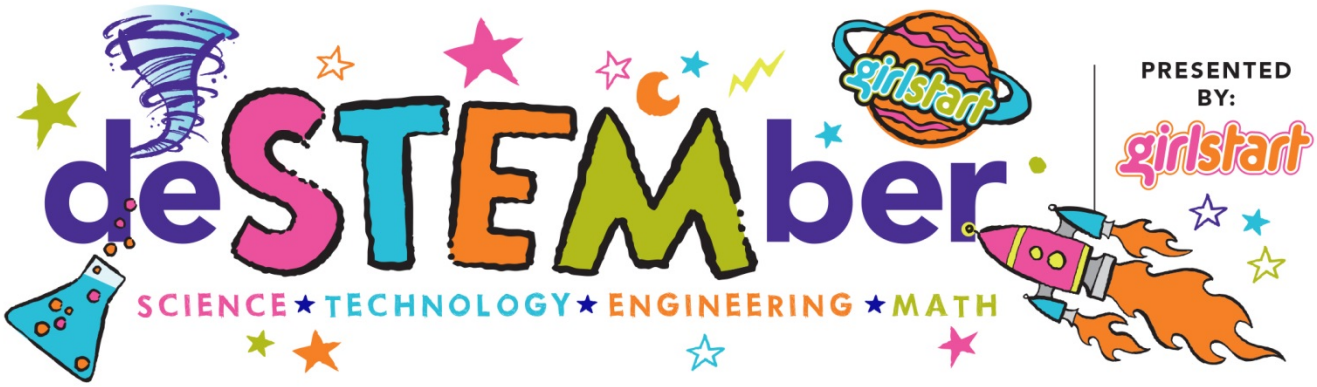
- Strips of black construction paper (2" x 4" is a good size)
- Non-nano sunblock (e.g. zinc oxide ointment, found at any drugstore)
- Nano-sunblock with zinc oxide; make sure the product is labeled as "goes on clear" (refer to the list at the bottom of the activity for common nano-sunblock brands)
- Paper towels
- Picture with large white dots/black background (included below)
- Picture with small white dots/black background (included below)
- List of common mineral sunblocks/sunscreens (included below)

How To:

1. Lay out all supplies. Discuss that the purpose of using sunblock/sunscreen is to protect the skin from ultraviolet light, which can cause short-term (sunburn) and long-term (pre-mature aging and skin cancer) damage.
2. Apply a small dot (half the size of a pea is more than enough) of both types of zinc oxide onto a strip of black construction paper. Rub each dab of sunblock into the paper until it disappears. Which dot disappeared more quickly?
3. Both sunblocks contain zinc oxide, a mineral that is very effective at absorbing UV radiation to prevent it from reaching your skin. The difference between the two sunblocks is in the size of the zinc oxide particles. The regular zinc oxide leaves a more visible film (a.k.a. “the lifeguard nose”) because the particles are large enough to reflect visible light. The nano-sunblock is transparent because the zinc oxide nanoparticles are too small to reflect visible light. They are still large enough to absorb UV radiation, so protection is equally effective. Based on this information, label the two dots on your construction paper as either “nano” or “non-nano”.
4. Look at the two pictures of large and small white dots. Which dots are easier to see? Right, the large dots. The image with the large dots represents regular sunblock – the large white dots reflect more visible light than the smaller dots, so they are more visible. The image of the small dots represents the nano-sunblock – each smaller particle reflects less visible light, so collectively they are harder to see and allow for the nano-sunblock to appear transparent. The large dot image has been scaled down and tiled to form the image of the small dots, so the ratio of black to white is the same in both pictures; only the distribution is different.







Why Does It Work?

Although the public and manufacturers often use the words “sunblock” and “sunscreen” interchangeably, they technically refer to two different types of sun protectants. Sunblocks refer to sun protectants that contain minerals such as zinc oxide or titanium dioxide. They block about 99% of UV radiation, but non-nano formulations are opaque in nature and users rarely apply the amount recommended for effective protection as a result. Sunscreens refer to chemically based sun protectants, few of which individually protect against both UV-A (320–400 nm) and UV-B (290–320 nm) radiation and are usually combined into broad-spectrum products. Although chemical sunscreens also degrade when exposed to UV light, they are more transparent than traditional mineral sunblocks when rubbed on the skin. In light of this, chemical sunscreens tend to be more popular than mineral sunblocks, even though mineral sunblocks are better at blocking UV radiation and are better for the skin because they do not degrade.

When the diameter of a zinc oxide molecule is reduced below the wavelength of visible light (380–780 nm), the nanoparticle no longer scatters visible light so the substance containing the mineral will look transparent. However, the particles are still larger than the wavelength of ultraviolet light and the chemical composition of the particle is not altered, so zinc oxide does not lose its ability to absorb UV radiation.

Nanoparticles used in sunblocks are some of the most extensively researched topics in nanotechnology. Although Australian and European governments have approved the use of nanoparticles in sunblocks, cosmetics, including sunscreens, are not regulated by the U.S. Food and Drug Administration (FDA). It is often difficult to tell which commercially available products contain nano and non-nano mineral formulations, since cosmetics companies are not required to indicate whether nanoparticles are present in their product.

To date, toxicity studies have shown that nano-zinc and titanium based minerals do not penetrate the outer later of healthy skin and are largely safe to use. However, a possible penetration risk remains in areas where skin is thinner (i.e. lips, underarms, eyelids and at the joints) or if skin has been damaged by prior sun exposure or other physical trauma. Additionally, the elderly and young children may have a higher risk of skin penetration, as these age groups tend to have thinner skin. The primary health concern about nanoparticles is that if they are exposed to UV radiation they can generate oxygen free radicals; these can cause oxidative stress and inflammation as well as damage proteins, lipids, and DNA.

Career Connection:

Nano Careers: Check out fun careers in nanotechnology here: http://www.wonderville.ca/asset/nano-careers

Resources:

- Adapted from Invisible Sunblock Activity , developed by NISE Network for the NISE Network, with funding from the National Science Foundation under Award Numbers 0532536 and 0940143. Any opinions, findings, and conclusions or recommendations expressed in this report are those of the authors and do not necessarily reflect the views of the Foundation. Used under CC BY NC SA 3.0 US, reformatted for DeSTEMber activity directory.

Additional Resource:

- Video – A Little Bit of Sunshine: http://vimeo.com/73257929

COMMON MINERAL SUNBLOCKS AND SUNSCREENS*

BRAND	NANO?
Banana Boat Kids Tear Free SPF 30	YES
Blue Lizard Baby/Regular/Sensitive	YES
Burt's Bees Chemical-Free Sunscreen SPF 15	YES
California Baby SPF 30+ Sunscreen	YES
Dermatone Lips 'n Face Protection Creme and Sunblock Creme	YES
Fallene Cotz SPF 58	YES
Innovative Skincare Clinical SPF 20 Moisturizing Treatment Sunscreen	YES
Keys Solar Rx SPF 30+ Nano-Zinc Oxide Sunblock	YES
Mustela Bébé/Enfant High Protection SPF 50	YES
NuCelle SunSense SPF 30+ Sunscreen	YES
SkinCeuticals Daily Sun Defense SPF 20	YES
Sun Smart Applied Therapeutics	YES
Lavera Sunblock SPF 40 Neutral	NO
Jason's Chemical-Free SPF 30+ Sunblock	NO
Zinc Oxide ointment (from any drugstore)	NO

*Mineral sunblocks and sunscreens contain zinc oxide and/or titanium dioxide, which protect you from UV rays but are not absorbed into your skin.

Sources:
National Geographic (2006) The Green Guide Sunscreens and Sunblocks Product Report (http://www.thegreenguide.com/reports/product.mhtml?id=27)
Woodrow Wilson Center for International Scholars (2007) Inventory of Nanotechnology Consumer Products (http://www.nanotechproject.org/index.php?id=44&action=intro)