Exploring Materials—Ferrofluid

Can a liquid be a magnet?

NanoDays
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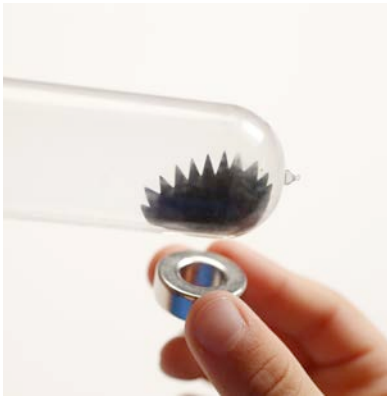
Try this!

1. Move a magnet around next to the vial of black sand. How does the sand react?
2. Do the same thing with the vial of ferrofluid. Does the ferrofluid act the same way the sand does?
3. Now, hold the magnet next to the crisp dollar bill. What happens to the money?



What's going on?

Ferrofluid is a unique material that acts like a magnetic solid *and* like a liquid. In contrast, black sand is a regular magnetic solid. Surprisingly, both ferrofluid and black sand are made of magnetite! The difference in their behavior is due to size.

Ferrofluid is made of tiny, nanometer-sized particles of coated magnetite suspended in liquid. When there's no magnet around, ferrofluid acts like a liquid. The magnetite particles move freely in the fluid. But when there's a magnet nearby, the particles are temporarily magnetized. They form structures within the fluid, causing the ferrofluid to act more like a solid. When the magnet is removed, the particles are demagnetized and ferrofluid acts like a liquid again. Black sand is also made of magnetite, but it doesn't have ferrofluid's unusual properties because the grains of sand are much larger.

The dollar bill moves because the ink used in printing contains ferrofluid! This special ink is used to deter counterfeit printing. The ferrofluid used in the ink also helps vending machines know if you've put in $1 or $5 or $50!

How is this nano?

Inside a hard drive

A material can act differently when it's nanometer-sized. (A nanometer is a billionth of a meter.) Nanometer sized magnetite particles suspended in liquid (ferrofluids) behave like *paramagnets*, meaning that it's magnetic only in the presence of a magnet. But on the macroscale, magnetite is permanently magnetic.

Nanotechnology takes advantage of special properties at the nanoscale—such as paramagnetism—to create new materials and devices.

In addition to the ink used in printing US dollar bills, ferrofluid is used in rotary seals for computer hard drives and other rotating shaft motors, and in loudspeakers to dampen vibrations. In medicine, researchers are looking at ways to use ferrofluid as a contrast agent for magnetic resonance imaging (MRI).