

Be careful!

DO NOT BREAK THE TUBES!
DO NOT OPEN THE TUBES!
DO NOT SHAKE THE TEST TUBES!

Handle with care. In case of contact with skin, wash with copious amounts of water and soap.

If the test tube breaks, do not throw the ferrofluid down a sink.

Do not bring the ferrofluid near a flame.



You will need

- Test tube containing black sand
- Test tube containing ferrofluid
- Blue button magnet
- A compass

What you can do

- Examine the tubes and their contents

What is the main difference between the magnetite sand and the ferrofluid?

- Put the magnet close to the test tube containing the black sand, let it slide along the test tube. **How does the sand react?** Remove the magnet from the test tube, **what happens?**
- Try the same things with the test tube containing the ferrofluid and look at the resulting shape. **What does it look like?** Remove the magnet. **What happens?**

Do ferrofluid and magnetite sand look the same then the magnet is near? What about when it is removed?

- Place the compass next to the magnetite sand. **What does the compass do?** Now shake the test tube and place the compass next to it. **What does the compass do now?**
- Now place the compass next to the ferrofluid. **What does the compass do?** Place a magnet next to the ferrofluid tube for a little while. Remove the magnet and quickly put the compass next to the tube. **What happens?**

Do the magnetite sand and the ferrofluid have the same effect on the needle of the compass?

Do you have any ideas what ferrofluid could be useful for?



What's happening?

Ferrofluid and black sand are made of the exact same material: **magnetite**, an iron oxide. But, the ferrofluid is made of **nanometric** crystals of magnetite whereas black sand is made of macroscopic grains of magnetite.

This size difference explains why, when in the presence of a **magnetic field**, ferrofluid and black sand don't behave in the same way. Black sand, as shown by the compass, is permanently magnetic even in the absence of a magnet. Ferrofluid is a unique material that acts like a magnetic solid in the presence of a **magnetic field**, but like a non-magnetic liquid if there is no **magnet** around.

Ferrofluid has several potential technological applications in mechanics, industry, electronic devices and in the future, maybe even in medicine.

To find out more

- Art and ferrofluid:
http://www.youtube.com/watch?v=CJGBy_yygaQ
- <http://homes.nano.aau.dk/tgp/ferrofluid.pdf>
- <http://www.photonics.com/Content/ReadArticle.aspx?ArticleID=15447>
- <http://en.wikipedia.org/wiki/Ferrofluid>



What does it mean?

Magnetite is a brown/black iron oxide that is magnetic. Magnetite occurs in many different types of rocks and is an important source of iron.

A **magnet** is an object made of iron, steel, nickel or cobalt that creates an invisible magnetic field around itself.

A **magnetic field** is the region surrounding a magnet where its influence is detectable. Materials that can be magnets are attracted to magnetic fields.

A **compass** is a freely turning magnet which shows the direction of a magnetic field. If no magnet is around, the compass shows the direction of the magnetic poles of the Earth.

A **nanometre** is a billionth of a metre (0.000 000 001 m)