

### You will need

- The magnetic surface to be investigated
- Magnetic probes
- Two bar magnets



### What you can do

- Bring the opposite poles of your bar magnets close to each other.

#### **Can you stop them from touching?**

- Now turn one of the magnets around so that you are bringing the same poles together.

#### **Can you make them touch?**

#### **What does it feel like?**

- Take your magnetic probe and hold it with the dark magnetic side facing down. Run the 'probe' slowly across the magnetic surface from left to right as shown over the page in pictures 1 and 2.

#### **What does it feel like?**

- Now pull the 'probe' the other way - from top to bottom.

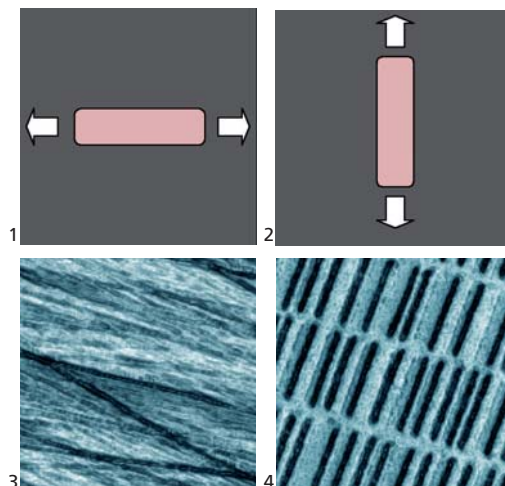
#### **Does it feel the same? What's different?**

- Can you draw what you think the surface looks like?
- Can you think of anything that works by detecting pits in the surface of a material?
- What about something that works by detecting magnetic fields?
- Pictures 3 and 4 are of the same object. Picture 3 shows the physical surface of the object while picture 4 shows its magnetic surface. What do you think the object might be?

## What's happening?

You should feel the probe leap across the surface as you move it at right angles over the invisible magnetic stripes. This happens because it is repelled and then attracted by the different poles it encounters. When you drag the probe parallel to the stripes it feels smooth because it encounters equal attraction and repulsion at all times.

This is a model of how an **Magnetic Force Microscope** works.



## To find out more

- <http://www.ou.edu/research/electron/www-vl/afm.shtml>
- [http://www.mrsec.wisc.edu/Edetc/reprints/ST\\_0612\\_46.pdf](http://www.mrsec.wisc.edu/Edetc/reprints/ST_0612_46.pdf)
- Lego AFM:  
[http://www.physics.unc.edu/~falvo/NUE/LEGO\\_AFM\\_WEBPAGES/web\\_files/nanoworld.html](http://www.physics.unc.edu/~falvo/NUE/LEGO_AFM_WEBPAGES/web_files/nanoworld.html)
- Explanation about Atomic Force Microscopy:  
<http://www.nanoscience.com/education/AFM.html>
- Explanation about Scanning Probe Microscopy:  
<http://www.mobot.org/jwccross/spm/>
- Black box: [http://www.nnin.org/doc/SPM\\_TG.pdf](http://www.nnin.org/doc/SPM_TG.pdf)

## What does it mean?

**Scanning probe microscopy (SPM)** is the general name given to microscopes that investigate surfaces by using very small tips.

**Atomic force microscopes (AFMs)** pull a very finely-tipped probe over the surface of a sample. The probe moves up and down as it goes over hills and valleys on the sample. A laser shining on the back of the probe detects this up and down movement and sends the information to a computer. The tip is in direct contact with the surface and can move the atoms around.

**Magnetic force microscopes (MFMs)** also work by pulling a tiny probe across the surface but the tip is magnetised. This means it is moved up and down by any tiny magnetic fields present on the surface of the sample. The tip is not in direct contact with the surface, but instead 'floats' about 10 nm above the surface.