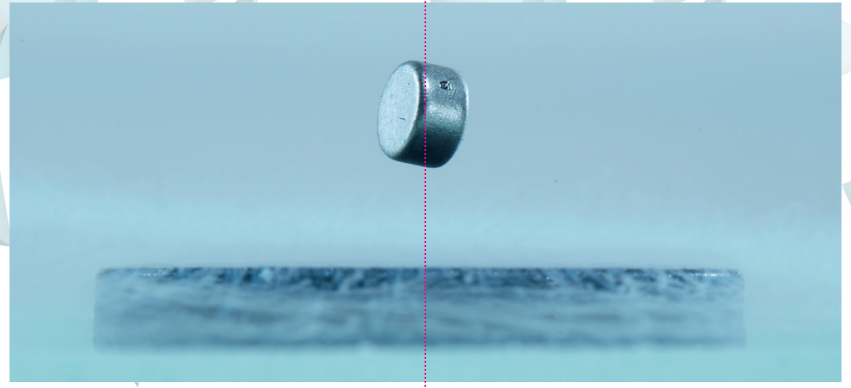
CAN SUPERCONDUCTORS, s. r. o.
Ringhofferova 66, 251 68 Kamenice, Czech Republic
tel.: +420 323 619 695, fax: +420 323 619 697
www.can-superconductors.com



DON'T use liquid nitrogen contaminated by oxygen. Pure liquid nitrogen is clear; if polluted by oxygen it is bluish. Long-term storage increases the concentration of oxygen in liquid nitrogen.

**For short-term storage a thermos bottle with a shell can be used. Remove the gasket/seal from the lid. Never screw the lid tight. Always leave a small space in-between. If there is no space between the lid and the bottle, the boiling liquid nitrogen can explode.*

Handling Rules for Liquid Nitrogen

Liquid nitrogen can be a dangerous substance if used incorrectly.
To avoid any risks follow these safety precautions:

KEEP the liquid nitrogen out of the reach of children.
KEEP liquid nitrogen in Dewar bottles*
USE the liquid nitrogen in well-ventilated areas only.
USE protective glasses.
USE tweezers to manipulate the experimentation objects.
USE insulated gloves.
DON'T touch any object cooled by liquid nitrogen with your bare hands before it has reached room temperature.
DON'T allow liquid nitrogen to have any contact with your body.
DON'T use liquid nitrogen on normal glass or plastic – they could shatter after being cooled by liquid nitrogen.

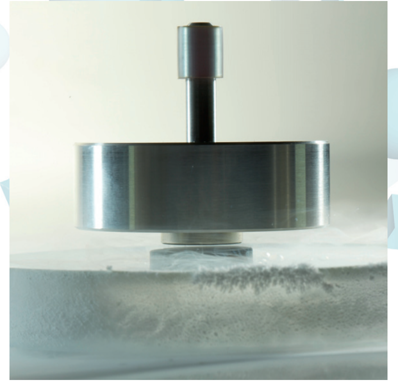
A superconductor cooled at a very low temperature can conduct more electrical current than a common copper conductor of the same size. The strong magnetic field produced by the coils of superconducting materials creates magnetic levitation. This phenomenon makes the construction of magnetic levitating trains possible. Since there is no friction during levitation, the train needs much less energy for motion.

Our demonstration kits were prepared to present the basic properties of superconductivity in an easy way. We believe you will enjoy working with them and discover new wonders within the fascinating world of physics.

Superconductivity

Superconductivity is a phenomenon that occurs when certain materials are cooled below their critical temperature. When cooled, they lose almost all the resistance to the flow of electrical current. Superconductors are not only perfect electrical conductors but they also have special magnetic characteristics.

The first superconductors were discovered in 1911. They are referred to as low temperature superconductors. They only exhibit their superconducting properties when cooled to almost 4 K (–269°C). Their practical use is limited because cooling to such a low temperature is very expensive. In 1986, there was a breakthrough in the superconductivity field with the discovery of high temperature superconductors (HTSC). They conduct even at temperature of 164 K (–109°C). Such cooling is possible at a considerably lower expense than cooling the low temperature superconductors. HTSC allowed the first practical applications of superconductivity.



Superconductivity Demonstration Kit

Instruction manual

can superconductors

Kit 1 Meissner Effect

About

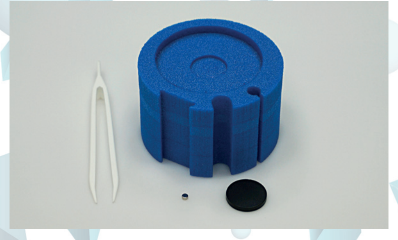
Using a high temperature superconductor (HTSC), this kit demonstrates the main magnetic property of superconductors called the Meissner effect, which was discovered by W. Meissner in 1933.

If the superconductor is cooled under a weak magnetic field to a temperature below its critical temperature, T (below T, the superconductors become superconducting – they lose the electrical resistance), **the magnetic field is extracted from the superconductor's volume without penetrating it,** causing the superconductor to become perfectly diamagnetic. **This property of superconductors is called the Meissner effect.**

The pure Meissner effect can only be observed under a weak magnetic field. But if the high temperature superconductors (belonging to the type of superconductors that conduct strong magnetic fields) are used, the situation is more complicated.

A stronger magnetic field is extracted only partially and a part of the magnetic flux penetrates the superconductor. Nevertheless, the demonstration of the magnetic flux expulsion using HTSC is easy and simple with the use of liquid nitrogen as a coolant to bring the superconductor below its critical temperature.

This kit demonstrates the levitation of a small rare earth magnet above the high temperature superconductor caused by the partial expulsion of the magnetic flux from the HTSC volume.



Superconducting disc
Material: Polycrystalline HTSC ceramics
Composition: $YBa_2Cu_3O_{7-x}$
Diameter: approx. 22 mm
Critical temperature: 90 K (–183˚C)
Small permanent magnet
Diameter: 4 mm

Kit Includes

1 Insulated experimentation cup
2 Small NdFeB magnet
3 Superconducting HTSC disk
4 Tweezers
5 Instruction for use and rules of handling liquid nitrogen

**Liquid Nitrogen not included*

Instructions

1 Put the superconductor disk into the experimentation cup and place the small NdFeB magnet on the top of the disk.
2 Pour a small amount of the liquid nitrogen into the cup until it reaches the top surface of the superconductor.
After one or two minutes, the magnet will float above the superconductor's surface demonstrating the magnetic flux expulsion from the superconductor.
3 Keep the superconductor in the superconducting state by occasionally pouring the liquid nitrogen into the cup.
Using tweezers, try to press the magnet to the superconductor's surface and/or move it above the superconductor surface.
4 After finishing, let the parts warm to room temperature then dry them properly before storing.

Kit 2 Strong Levitation

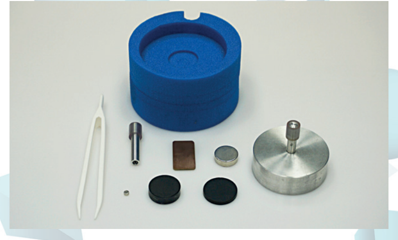
About

The kit demonstrates a strong levitation of a permanent magnet above the superconducting crystal showing its prospective use in the design of magnetic bearings.
In this case, **the levitation is not based on the Meissner effect** (an expulsion of a weak magnetic field from a superconductor's interior), **but on the trapping of the strong magnetic flux within the superconductor's interior.** The materials for the Meissner effect demonstration (a basic property of superconductors) are also included in this kit.

In the case of the type II superconductor, strong magnetic fields can penetrate the superconductor's volume and be trapped in the defects and grain boundaries of the crystal – the so called pinning centers.

If the superconductor is cooled below its critical temperature near an external magnetic field (e.g. near a permanent magnet) then the magnetic flux generated by the magnet will be trapped inside the superconductor. This will cause the attractive and repulsive magnetic forces to prevent a change to the mutual positions of the magnet and superconductor. High temperature superconductors (HTSC) belong to the type II superconductors and this effect can easily be demonstrated using liquid nitrogen as a coolant.

This kit demonstrates not only the strong levitation of a permanent magnet above the HTSC disk, but also causes a 0.1kg superconducting magnetic top, levitating and spinning above an HTSC crystal.
It is a simple demonstration of frictionless superconducting magnetic bearing, which is applicable e.g. in flywheel systems for energy storage.



Superconducting crystal
Material: highly textured HTSC
Composition: Y-Ba-Cu-O
Preparation method: seeded melt growth
Diameter: approx. 21 mm
Critical temperature: 90 K (–183˚C)
Permanent magnet
NdFeB, diameter: 15 mm

Kit Includes

1 Insulated experimental cup
2 Superconducting crystal
3 Spacer
4 Magnet holder
5 NdFeB permanent magnet
7 Tweezers
8 Superconducting HTSC disk for Meissner Effect
9 Small NdFeB magnet for Meissner Effect
10 Instructions and rules for handling liquid nitrogen

**Liquid Nitrogen not included*

Instructions

1 Put the HTSC crystal into the experimentation cup and cool it with liquid nitrogen.
2 Tap the magnet holder on the surface of the magnet.
3 Test the repulsive force by pushing the magnet against the superconductor.
4 Let the magnet levitate above the superconducting crystal.

Spinning Top Demonstration:

1 Put the HTSC crystal and magnet (separated by the spacer) into the experimentation cup and cool the crystal with liquid nitrogen.
2 Using tweezers, remove the spacer. Put the top on the magnet and spin it. Spin it once and observe how the top can fly for many minutes without stopping.
3 Keep the crystal in the superconducting state by occasionally pouring liquid nitrogen into the cup.
4 After finishing, let the parts warm to room temperature then dry them properly before storing.
Do not expose the parts to temperatures above 70˚C.

See our demonstration videos at www.can-superconductors.com.