SUPERCOMET 2

Bernadette Schorn[*], Hermann Deger[§], Hartmut Wiesner[*], Raimund Girwidz[#], Leopold Mathelitsch[°]

[*]*Physics Education Research Group, University of Munich, Munich, Germany,*
[§]*Erasmus-Grasser-Gymnasium, Munich,* [#]*PH Ludwigsburg, Germany,*
[°]*Physics Department, University of Graz, Austria*

Abstract
The phenomena of superconductivity gain significance in the modalities of application steadily. In the EU-project about superconductivity (funded by the Leonardo da Vinci programme), SUPERCOMET2 (**SUPERCO**nductivity **M**ultimedia **E**ducational **T**ool), material (simulations, experiments, teacher guide, teacher seminar,…) is to be produced and evaluated for pupils and teachers of the upper secondary school [1].
The main themes concerning the work of the German partners are the following:

- translation and adaptation of developed material on the demands of the German and Austrian curriculum,
- testing and evaluating of existing material,
- producing and evaluating of material about making superconductors for hands-on kits,
- producing and evaluating of material about possibilities of application of superconductors,
- development and adaptation of the teacher guide and teacher seminar.

This article describes the actual status of the German partners' contribution.

Introduction

In the previous project SUPERCOMET material like complete e-modules about electricity, magnetism and superconductivity have been developed. These contain animations, texts, quiz game, a glossary of important terms plus a FAQ section, a search engine as well as some literature references and links to useful online resources. The corresponding teacher guide to the computer application and the complete e-modules are already translated. At the moment, they are being tested and adapted to the German and Austrian curriculum.

Further proceedings

Another focus is the baking of superconductors and the production of material for the fabrication of superconductors for hands-on kits and their application in school. Therefore, pellets of YBaCu superconductors, which have been discovered by C.W. Chu shortly after the discovery of high-temperature superconductors by J.G. Bednorz and A. Müller (1986), are being baked. They can also be produced at school [2]. Their T_c is around 80K, which is high enough to use cheap liquid nitrogen (77K). The recipe for baking such superconductors reads like one for a cake: take three different powders in well balanced quantities, mix them thoroughly, crush the mixture in an agate mortar and press tablets (figure 1, 2, 3).

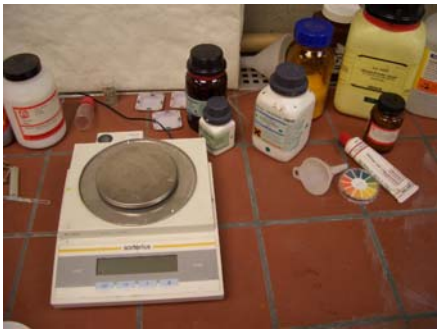

Figure 1: *Utilities*

Figure 2: *Mixture*

Figure 3: *Press*

After the tablets have been baked in a special oven at 950°C for more than one day, they have to be cooled within two more days. Afterwards, the tablets have to be crushed, pressed and baked once again.

Figure 4: *Oven*

Figure 5: *Regulation*

After the baking process the superconductors can be tested. If the sample is very small, it is better to use a toric magnet and let the cooled sample float above. The sample will heat above T_c within some seconds and then stop floating (figure 6). A big self-made sample is laid in liquid nitrogen. If a strong magnet floats above the sample, the sample passes the test of superconductivity (figure 7).

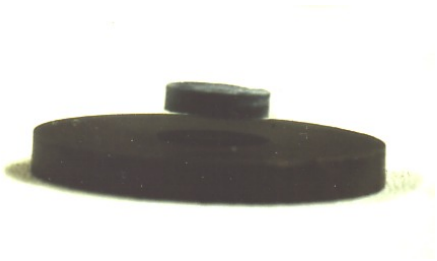

Figure 6: *Small sample*

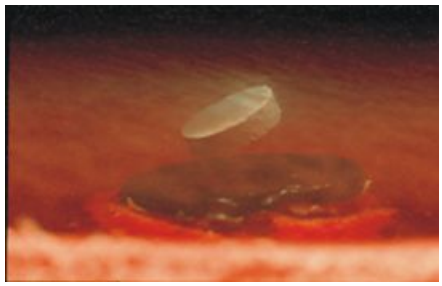

Figure 7: *Big sample*

For the Meißner-Ochsenfeld-Effect the magnet is laid on the sample at room temperature. According to classic laws no floating should happen as the magnetic field does not change any more. But after cooling the sample the magnet will float. That shows that superconductivity is more than perfect diamagnetism.
Another possibility to show the fascinating properties of superconductors is the so called Thomson-Experiment (figure 8): With a ring of copper or aluminium you observe a little effect. When switching on the magnet, the ring gets a little kick away from the magnet, then it returns while the magnet is still active. With the YBaCu-sample you get a long time effect, which is quite impressive.

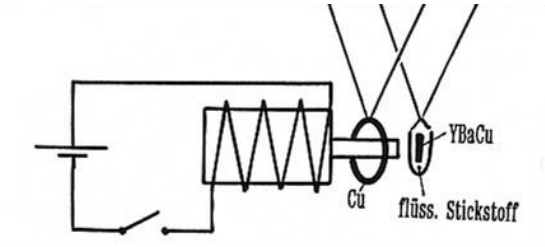

Figure 8: *Thomson-Experiment*

Furthermore you can build a magnetic track and let float a cooled sample above it (figure 9): You cut stripes from magnetic rubber and form a racing track. The YBaCu-sample that was cooled below T_c floats above some magnetic lines. The starting point of the track is a little higher than the rest of the track. The well cooled sample will float some seconds before it is heated above T_c.

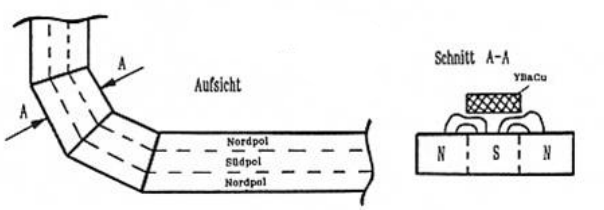

Figure 9: *Magnetic track*

The baking of theses YBaCu high-temperature superconductors and the experiments described above have been accomplished successfully.

Outlook

In the future advanced experiments like the so called 4-point-measurement method shall be prepared and accomplished (figure 10). A self-made sample (diameter 10mm) is prepared for electric measurement. You need four contacts to measure the vanishing resistance.

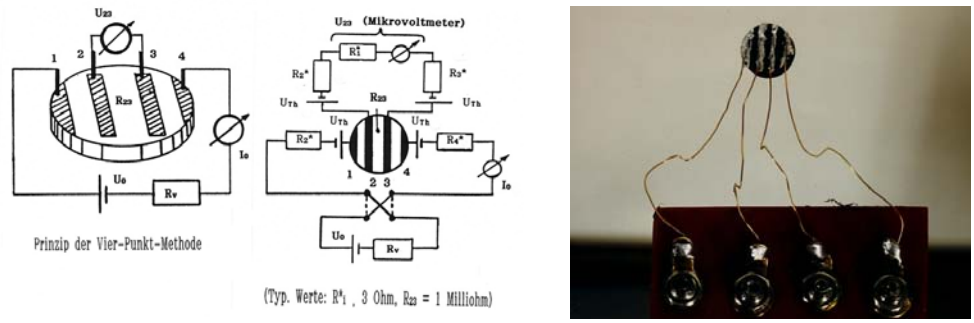

Figure 10: *4-point-measurement method*

Solder contacts are applied to self-made superconductors. Thus the vanishing resistance below the critical temperature T_c can be shown: A battery and a constant resistor keep the current constant (figure 11). The micro-voltmeter at the sample indicates normal conductivity at room temperature. Now the sample is cooled with liquid nitrogen and thus becomes a superconductor. With the change of the temperature the resistance changes correspondingly. This relation is shown in figure 12.

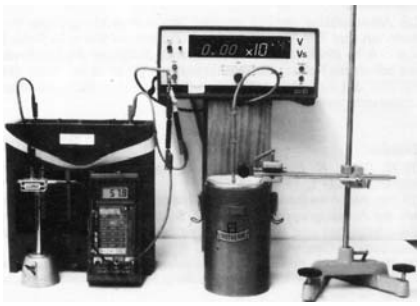

Figure 11: *Experimental setup*

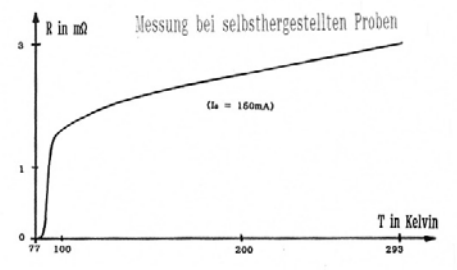

Figure 12: *Relation between temperature and resistance*

Work on material about possibilities of application of superconductors is in progress. Examples are possibilities of the advancement of medical diagnoses via magnetic resonance tomography (MRT), in the area of maglev and the realisation of tomorrow's supercomputers.

Literature / References

[1] SUPERCOMET-project: www.supercomet.no

[2] Deger, H. (1991): Moderne Physik im Unterricht: Fachdidaktische Anregungen und Studien zum Bereich der Festkörperphysik. Palm & Enke, Erlangen