Superconductors: today and in the future

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What is a Superconductor?

- A superconductor is a very pure metal, an alloy or a compound that allows electricity to be transmitted with minimal losses.
- A higher current flow may occur with lower energy losses than common conductors.
- Many elements can be coaxed into a superconductive state with the application of high pressure.

Type 1 Superconductors

- are very pure metals characterized as the “soft“ superconductors
- were discovered first and require the coldest temperatures to become superconductive
- they exhibit a very sharp transition to a superconducting state and
- "perfect" diamagnetism - the ability to repel a magnetic field completely
- have too low critical magnetic field Bc and are not attractive to industry
- have different crystal lattices – **FCC, BCC, HEX, TET, ORC, RHL**
- BCS theory explains the behaviour of these superconductors by means of Cooper pairs

Type 2 Superconductors

- Elements (**V, Tc, Nb**), compounds or alloys, copper perovskites, rare ferromagnetic superconductors, superconducting pyrochlore crystals - known as the "hard"superconductors
- differ from Type 1 in that their transition from a normal to a superconducting state is gradual across a region of "mixed state" behaviour
- have two critical magnetic fields – Bc_1 and Bc_2. Below Bc_1 the superconductor excludes all magnetic field lines. At field strengths between Bc_1 and Bc_2 the field begins to intrude into the material. When this occurs the material is said to be in the mixed state, with some of the material in the normal state and part still superconducting. At Bc_2 the superconductor stops superconducting.
- with high critical temperature, critical current and critical magnetic field
- extremely attractive to industry
- crystal lattice – **TET, ORTH**
- the behaviour of these superconductors is not explain yet

Atypical superconductors

- **Fullerenes**
- **Organic superconductors**
- **Borocarbides**
- **Heavy Fermions**
- **Ruthenates**
- **Tungsten-bronze systems**
- **Fluoroargentates**

Applications of Superconductors

- **Superconducting magnets**

- **Superconducting cables -** First HTS cable installation in a utility network is scheduled for the year 2000. The first HTS coaxial HTS cable demonstration is scheduled for that same year. The first commercial sales of HTS cable wires are expected shortly after 2001

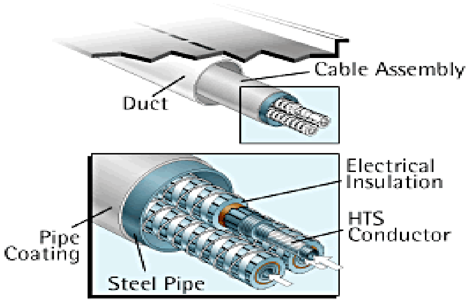
- **Superconducting wires**
- **Scanning SQUID microscope**
- **Devices that use the absence of resistance of superconductors**
  - High current superconducting wires.
  - Radio Frequency filters in cell phone receivers

- **Superconducting quantum devices**
  - To define the Volt
  - "Quantum Metrology"
  - As magnetic field detectors

String of SC Magnets – 7

Relativistic Heavy Ion Collider RHIC), ~ 4 miles of SC magnets. Brookhaven National Laboratory

Superconducting cables



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The warm dielectric cable configuration features a conductor made from HTS wires wound around a flexible hollow core. Liquid nitrogen flows through the core, cooling the HTS wire to the zero resistance state. The conductor is surrounded by conventional dielectric insulation. The efficiency of this design reduces losses.

Superconducting wires