

# SUPERconductors

## SUPER - prize

If you want a Super Prize you should think of SUPERconductivity

## Applications

### SUPERspeed Maglev



上海磁浮交通有限公司 上海磁浮 通往世界的门户

Maglev Demonstration Line - from Pudong International Airport to Longyang Road Metro Station - the 30-kilometer trip will take only eight minutes. It is the world's first commercial magnetic levitation line. From March 29 2004, it was put into use formally and operates everyday from 8:30am to 17:30pm. The operation interval is 20 minutes.

The round trip ticket cost 80 yuan and the one way ticket cost 50 yuan. Passengers with current day flight ticket can buy a one way ticket of Maglev Train at 20% discount. Add: Maglev Train Station of Longyang Rd

Price(RMB):  
One Way Ticket:50, 100(VIP)  
Round Trip Ticket:80, 160(VIP)  
Tel:28907777

## SUPERman



## SUPER SENSITIVE SQUID

SQUIDS: The most sensitive detectors of magnetic fields

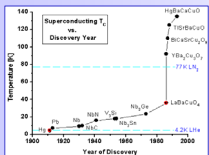
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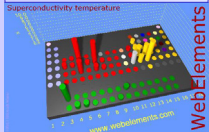
Normal SQUID [1]

1913	For his investigations on the properties of matter at low temperatures which led, inter alia, to the production of liquid helium*	Heike Kamerlingh Onnes
1962	For his pioneering theories for condensed matter, especially liquid helium**	Lev Davidovich Landau
1972	For their jointly developed theory of superconductivity, usually called the BCS-theory**	John Bardeen / Leon Neil Cooper / John Robert Schrieffer
1973	For their experimental discoveries regarding tunneling phenomena in semiconductors and superconductors, respectively* for his theoretical predictions of the properties of a supercurrent through a tunnel barrier, in particular those phenomena which are generally known as the Josephson effects**	Leo Esaki / Ivar Giaever Brian/ David Josephson
1987	For their important break-through in the discovery of superconductivity in ceramic materials**	J. Georg Bednorz / K. Alexander Müller
2003	for pioneering contributions to the theory of superconductors and superfluids*	Alexei A. Abrikosov / Vitaliy L. Ginzburg / Anthony J. Leggett

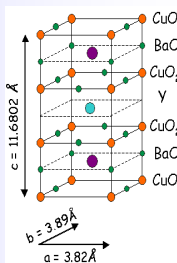
## Superconducting Materials



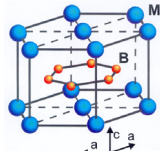
Discovery of materials with successively higher T<sub>c</sub>'s over the last century. (Points circled in red garnered a Nobel Prize for their discoverers: Kamerlingh-Onnes in 1913 and Bednorz & Müller in 1987.)



## Superconducting Cuprates



<http://hoffman.physics.harvard.edu/research/Scmaterials.php>

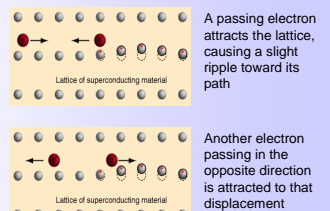


A surprising discovery came in 2001: crystallographically simple  $MgB_2$  becomes superconductive at 39 K. Also lithium becomes superconducting, at high (48 GPa) pressure. Scientists do not exclude that even hydrogen, at high pressures, in metallic phase can be superconducting.

## Superconducting Electrons

Superconductivity is a kind of Bose-Einstein condensation. Unfortunately, only bosons, i.e. particles with the spin=1 (integer, in general) can condensate. Electrons are fermions, with spin =1/2. But if two electrons could couple, they would form a boson! The crystal matrix serves as a deformable mattress for this.

### A model of Cooper pair attraction



<http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html>

Superconducting materials:  
•about 30 elements are known (table A)  
•As, Be, Cs, Ge, Si and Te are only superconducting  
•oxide superconductors are a sort of ceramics (table B)

Non-superconducting materials:  
•normally good conductors e. g. Cu and Ag are not  
•magnetic materials e.g. Fe or Ni are not  
•transition elements are not

### [1] Superconducting Quantum Interference Device

A direct current SQUID, consists of two Josephson junctions employed in parallel so that electrons tunneling through the junctions demonstrate quantum interference, dependent upon the strength of the magnetic field within a loop.

text: [http://whatts.techtarget.com/definition/0\\_sqip\\_gsr16722\\_00.html](http://whatts.techtarget.com/definition/0_sqip_gsr16722_00.html)  
photo: <http://krissd.krisr.ez.kyquantum/supercon/squid.html>; see also: <http://superconductors.org/>



Bardeen, Cooper and Schrieffer waited 25 years to get the Nobel prize for explaining the superconductivity in metals. Immediately after, new superconductors were discovered, in "strange" materials, with complex crystalline lattices. We have no explanation for SC in copper oxides, at present.

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