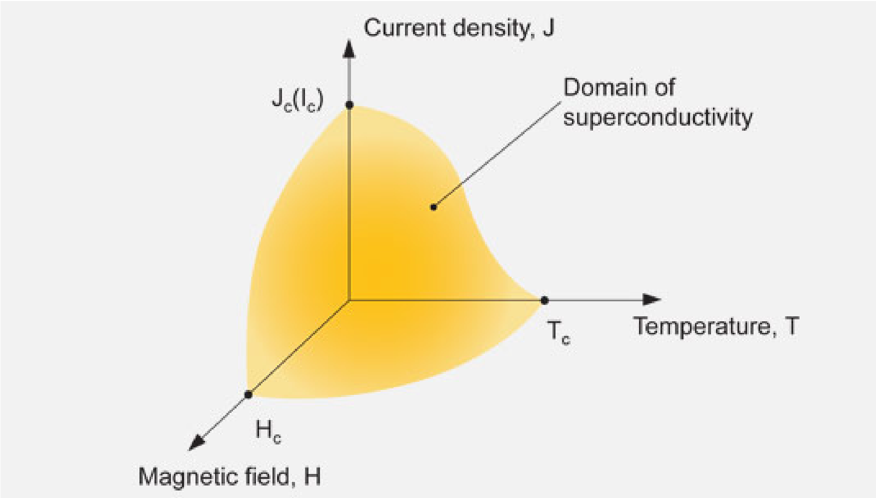
Superconductivity is a phenomenon at nanoscopic level that does not exist in nature, although relatively recently the first known superconducting mineral, 'covellite', was surprisingly discovered. A superconductor shows no electrical resistance to the flow of an electrical current if:

1. the current value is lower than a critical value named *critical current*, I_c;
2. it's cooled below a given *critical temperature*, T_c;
3. it's exposed to a magnetic field whose value doesn't exceed the *critical field* value, H_c.

Each of these parameters is very dependent on the other two properties. In order to keep material in its superconducting state both the magnetic field and the current density value, as well as the temperature one, have to be lower than corresponding critical values, all of which depending on the specific superconducting material.



The three critical parameters define a critical surface on the 3D space. Moving from this surface toward the origin, the material is in the superconducting state while in regions outside this surface the material is normal or in a lossy mixed state.

Since 1911, a huge number of superconductors have been synthesized, with constantly increasing critical temperature, whose record value currently exceeds 150 K (-120 °C). In order to become really useful, however, a superconductor should ideally present the highest possible figures for all the critical parameters mentioned above. Unfortunately, so far none of the known superconductors possess optimal values of all of them. Moreover, cost, workability, complexity, toxicity, reproducibility, are amongst the main issues that also play a decisive role towards a possible commercial success of a superconductor.

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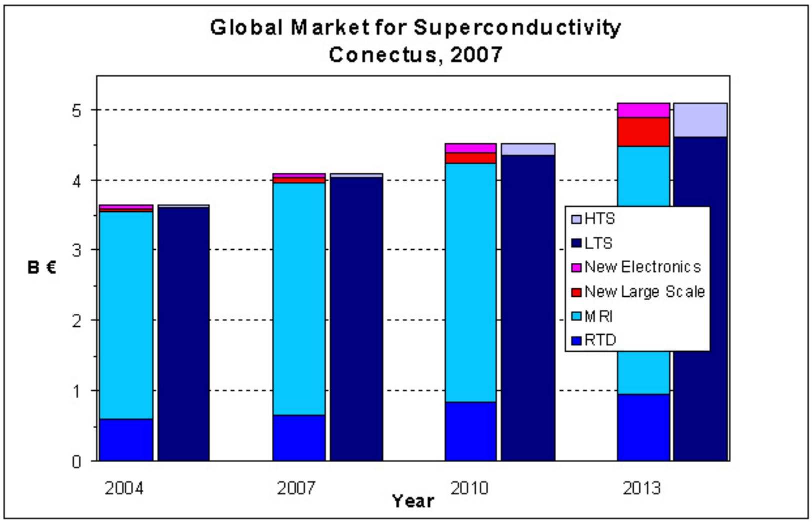
Before the mid eighties, practical applications and future expectations of technical superconductors were almost entirely the business of either pure Niobium, or its alloys, the most famous of them being NbTi and Nb_3Sn. These materials excel for their performance at temperatures around that of liquid helium (4.2 K), but fail to be usable at temperatures of the order of 20K and above, that would open up the use of cheaper and/or more convenient cooling techniques (i.e. cryogenic-free, liquid nitrogen/neon/hydrogen, etc.). In spite of that, NbTi and Nb_3Sn, in form of wires, have nowadays become a commodity in the superconductivity market, as they are widely used in a few practical applications that currently constitute a world market value exceeding 3 B$ in 2005.



In 1986, the biggest breakthrough in the Superconductivity world since 1911 appeared with the discovery of Cuprate High Temperature Superconductors (HTS), by Nobel Prizes Bednorz and Müller. Because of their critical temperature values, well above that of the cheap and readily available liquid nitrogen coolant, these new materials have changed forever the impact that superconductivity will have on the everyday world of the future. The reason why we are not already dealing with HTS in every electro-technical devices is that the high complexity and cost of HTS is still delaying their foreseen time to market. The recent advent of so-called 2G HTS materials based on Yttrium-Barium-Copper-Oxide coated tapes will certainly contribute to reach this target, sooner or later.

The discovery of Cuprate HTS has not halted the research on new superconductors and, in January 2001, the community has been again astonished by the sudden announcement of Akimitsu et al., reporting superconductivity at **40 K** in a very simple and already well known binary compound: **Magnesium Diboride** (**MgB_2**). This surprisingly simple compound is although quite unique for its properties, as it lies in between traditional Nb-alloy superconductors and the HTS from different viewpoints. This material can be readily manufactured into wires, and is based on precursors which are very abundant in nature and cheaper than for any other competing superconductor. In spite of its recent discovery, MgB_2 has already shown its full potential as a superconductor that can

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represents a logical step of evolution in the upcoming years for most of the applications which are now counting on Nb-alloy superconductors and while waiting for the Cuprate HTS to reach their targets.

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