The Global Market for Superconductivity Applications was Worth More Than $5.7 Billion in 2020
By BCC Research
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THE GLOBAL MARKET FOR SUPERCONDUCTIVITY APPLICATIONS WAS WORTH MORE THAN $5.7 BILLION IN 2020

Superconductors’ global market was worth more than $5.7 billion in 2020 and is forecast to reach almost $9 billion by 2025, growing at a compound annual growth rate (CAGR) of 9.2% over the next five years.

Fundamental properties of superconductors, which include repelling external magnetic fields and providing zero resistance to the electrical current, make them not only scientifically fascinating materials to study, but also technologically necessary materials to develop.

Currently, superconducting magnets, particularly those used in science, research, technology development and healthcare applications, dominate the market by capturing more than 94% of the total market ($5.4 Billion). However, with recent development in superconducting electrical equipment (e.g., transformers, generators, motors, fault current limiters, power storage, current leads and cable), by 2025 the superconducting magnets will capture only 77% of the total market while superconducting based electrical equipment market will grow at CAGR of 38.7% and is expected to capture 19.5% ($1.7 million) of the total market by 2025. Superconducting electronics are also projected to gain significant market share over the next five years at CAGR of 47%.

Critical applications for driving the superconducting market are divided into three main categories:
1. SUPERCONDUCTING MAGNETS

The global market for superconducting magnets reached $5.4 billion in 2020, and it is forecast to reach $6.9 billion by 2025 with a CAGR rate of 5.3%.

- Superconducting magnets are powerful electromagnets constructed using superconducting coils. These count for 78% of the total market share of Superconductivity applications. These coils are mostly made of NbTi and Nb$_3$Sn in an Al or Cu matrix and can generate a magnetic field of up to 15 Tesla. Superconducting magnets are being utilized by science, research, and technology development in Argonne National Lab, Fermilab, Relativistic Heavy Ion Collider, Large Hadron Collider particle accelerator, Alpha Magnetic Spectrometer and Fusion Reactor ITER. In 2020 the market was valued at $3.5 billion with an estimation of reaching $4.6 billion in 2025 with a CAGR of 5.7%. Healthcare industries and the application of MRI and Nuclear Magnetic Resonance applications are the second largest application in this market with an evaluation of $2 billion in 2020 and a forecast of $2.4 billion with a CAGR of 4.8%.

2. SUPERCONDUCTING ELECTRICAL EQUIPMENT

The global market for Superconducting Electrical Equipment reached $338 Million in 2020, and it is forecast to reach $1.7 billion by 2025 with a CAGR rate of 38.7%.

- **Transformers**: Superconducting transformers offer higher efficiency and greater power density than conventional transformers. Their greater efficiency means they can be smaller than their conventional counterparts, which is an important asset, especially in urban areas where site space is increasingly limited. The main application for superconducting transformers is in electrical power distribution systems.

- **Generators**: Superconducting generators use superconducting wire for the field winding instead of copper. A major benefit of thin film high-temperature superconductor (HTS) generators is lowered armature reactance. This advantage can profoundly impact utility stability considerations. One result is a reduction in the amount of spinning reserve (the unused but rotating generating capacity) needed to ensure a stable overall power system. In addition, an HTS generator can be significantly overexcited to permit power-factor correction without adding synchronous reactors or capacitors to the power system. Superconducting generators are being utilized by electric power generation, transmission transportation and military/defense.

- **Motors**: Superconducting motors are AC synchronous motors that employ HTS windings in place of conventional copper coils. Because HTS wire can carry significantly larger currents than copper, these windings can generate more powerful magnetic fields in a given volume of space. As a result, a superconducting motor can match the power output of an equally rated conventional motor with as little as one-third the size and weight that uses superconductor windings in place of conventional copper coils. These motors are being utilized by transportation, military/defense, and process industries.

- **Fault current limiters (FCLs)**: Superconductor devices that limit fault currents, such as short circuits. Several companies are working on commercializing FCLs. Most of these early FCLs use MgB$_2$, wire or YBCO tape and, in one case, BSCCO-2212 rods. LTSS are impractical for commercial FCLs because the AC losses at the required liquid helium temperatures make the devices impractical from an economic standpoint. FCLs superconductors are being utilized by electric power generation and transmission transportation. The market for FCLs reached $69 million in 2020, and it is forecasted to reach $360 million by 2025 with a CAGR of 39%.

- **Power storage**: Superconducting energy storage include magnetic energy storage, and flywheel energy storage (FES). Superconducting power storage is being utilized by electric...
power generation and transmission. The market for superconducting power storage is forecasted to reach $100 million by 2025.

- **Current leads:** HTS current leads represent the first large-scale application of high-temperature superconductivity. This is possible because even modest-current density HTS material can be used to provide a significant reduction in the parasitic heat conducted into a cryogenic environment via the electrical leads used to provide current to the device. There are two basic commercial technologies for HTS leads: Bulk rods of ceramic superconductors and metal-matrix superconducting composites. The leads are made from a variety of materials, including YBCO, Bi-2212, and Bi-2223 superconductors.

- **Wires:** Superconducting wires conduct electricity with little or no resistance or related energy loss. They can carry up to 140 times the current carried by similar-sized copper wires, thereby providing ample capacity for future expansion while requiring no increase in the number of overhead access lines or underground conduits. Superconducting wires are an integral part of many superconductor applications, such as superconducting magnets, transformers, generators, and motors. Most HTS wire and cable currently available use filaments of Bi-2223. First-generation HTS wire is a composite structure often containing more than 50 filaments of superconducting material (e.g., Bi-2223) embedded into a non-superconducting matrix such as a silver alloy. Second-generation wires are made by depositing HTS materials such as YBCO onto inexpensive metal templates coated with ceramic buffer layers. Second-generation HTS wire is expected to be two to five times cheaper than first-generation wire.

### 3. ELECTRONIC

The global market for electronics parts made from superconductors reached $35 million in 2020, and it is forecasted to reach $240 million by 2025 with a CAGR rate of 47%.

- **Integrated circuits:** Superconducting integrated circuits (ICs) use a multilayer structure of superconducting, insulating, and resistive films. Several of the superconducting IC applications use low-temperature superconductors (LTSs), particularly Niobium. HTS circuits made from YBCO thin film deposited on Si wafers, are at a less advanced stage of development. HTS ICs are expected to have important niche applications in handheld equipment and satellite payloads, where low weight, size, and cooling power consumption (compared to the same for LTS) are decisive issues. In large-scale ICs, however, HTS faces fundamental technological problems, as the advantage of operating at higher temperatures is diminished by the increased thermal noise. Currently, science, research and technology development, and communications computing are leading end-users for superconducting ICs. The global market of ICs reached $20 million in 2020, and it is forecasted to reach $219 million by 2025 with a CAGR of 61.5%.

- **Radio-frequency and microwave filters:** Superconducting radio-frequency filters with resonators fabricated from a superconducting material. HTS technology is attractive for use in RF and microwave filter applications. Although the surface resistance of a superconductor is not zero at radio frequencies (as opposed to the DC resistance of a superconductor), it is typically several orders of magnitude lower than that of even cryo-cooled copper. The ultra-low electrical loss of the superconductor yields RF resonators with extremely high-quality factors. The most extensive application in this market segment is filter systems for ground- or satellite-based wireless communication systems. Superconducting filters can result in improved coverage in rural areas and better usage of limited transmission bandwidths due to reduced interference in densely populated areas.

In 2020, 61% of the superconductivity applications supported science, research, and technology development initiatives, and around 34% of the market share was to support the healthcare system. In the last couple of years, extensive R&D coupled with technological innovations in academia and National Labs resulted in several promising discoveries and development in the superconducting field; hence more diverse end-use and industrial applications are expected for 2025.

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**About the Author:**


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