ED6-1-INV

The SQUID and its Applications in the Past 30 Years

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The introduction of the superconducting quantum interference device (SQUID) in the 1960's improved the sensitivity of magnetic sensing by several orders of magnitude. The SQUID enabled unprecedented sensitivity in measurements of electric current, voltage, temperature, susceptibility, and many other physical quantities. It allowed new ways for nondestructive evaluation of critical structures, for example, in airplanes or nuclear plants. Magnetic or conductivity anomalies below the earth's surface could be accurately revealed by measuring magnetic fields from above the ground. The SQUID has been used as detector in NMR, in MRI, bolometers, and accelerometers. One of the most notable applications of the SQUID is biomagnetism, where signals from the heart and brain or other organs are measured. The SQUID has enabled high-quality recordings of cardiac activity, spontaneous brain rhythms as well as evoked neuromagnetic fields, these fields being in the femto- to picotesla range. During the last 30 years, SQUIDs have been made more reliable and more sensitive. Large sensor arrays have been built in particular for biomagnetic applications. SQUID microscopy with tiny sensors have allowed submicron-resolution scanning of susceptibility, characterization of magnetic structures such as magnetic nanoparticles, and testing the quality of microcircuits. The discovery of high-transition-temperature superconductors motivated much work to develop devices that work in liquid-nitrogen temperatures. Several commercial companies now sell SQUID sensors for multiple applications. Here, the development of SQUID sensors and their use during the past 30 years will be described, the emphasis being in neuromagnetic applications.

Keywords: Magnetometer, Magnetoencephalography, Magnetocardiography, Ultra-low-field MRI

IEEE/CSC & ESAS SUPERCONDUCTIVITY NEWS FORUM (global edition), February 2018.
Received January 8, 2018; Selected January 24, 2018. Reference STP618.
Plenary presentation ED6-1-INV was given at ISS 2017, December 13-15, 2017, Tokyo, Japan.