A sensitive magnetometer utilizing high-T_c SQUID for magnetic property characterization

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ABSTRACT

Magnetometer is one of the indispensable instruments utilized for the magnetic property characterization of materials, where it evaluates the magnetic response originated from the materials. The non-invasive magnetic technique has promoted magnetometer to be utilized in new applications such as in biomedical applications. In this work, we report the development of a magnetometer utilizing a high critical temperature superconducting quantum interference device (high-T_c SQUID) and a flux transformer composed of an induction coil. The high-T_c SQUID is used in order to realize high sensitivity, compact, and low-running cost magnetometer for biomedical applications such as characterization of magnetic nanoparticles. A first-order planar gradiometer with a compensation coil was used as the detection coil to achieve high sensitivity and cancellation factor. We fabricate an electromagnet with primary and small secondary excitation coils to enable a wide range of the excitation magnetic field with a high resolution. To reduce the magnetic field's drift, we apply a digital feedback program to control the electrical current of the electromagnet. The performance of the developed system is demonstrated by measuring the magnetization curve and AC responses of an iron oxide composite sample. The sensitivity showed by the developed magnetometer reveals its potential for a highly sensitive magnetic property characterization.

KEYWORDS

Electromagnets; Iron oxides; Magnetic fields; Magnetic properties; Magnetometers; Medical applications; Molluscs; Quantum interference devices; Shellfish; SQUIDs; Superconducting coils

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