氏　　名	MOHD MAWARDI BIN SAARI
授与した学位	博　士
専攻分野の名称	工　学
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学位授与の要件	自然科学研究科　産業創成工学専攻 （学位規則第５条第１項該当）
学位論文の題目	Development of A Highly Sensitive AC/DC Magnetometer utilizing High-*T*c SQUID for Characterization of Magnetic Mixture Materials （磁性混合材料の評価のための高温超伝導 SQUID を用いた高感度 AC/DC 磁化率計の研究開発）
論文審査委員	教授　塚田　啓二　　教授　舩曳　繁之　　准教授　紀和　利彦

学位論文内容の要旨

Magnetometers have become considerably important nowadays in many fields owing to promising potentials of non-invasive magnetic technique. A magnetometer that possesses high sensitivity, compact and low-running cost is rather desired so that it is versatile compared to conventional magnetometers and applicable in many areas. This thesis reports a development of an AC/DC magnetometer using a high-Tc SQUID (high-temperature superconductor superconducting quantum interference devices) with a flux transformer. The critical feature of the system is the use of high-Tc SQUID and normal conductive detection coil, which enables the realization of a compact, highly sensitive and low-running-cost system. Optimizations and improvements performed during this work to increase the performance of the developed system are presented. Implementation of a feedback system of dual excitation coil enabled a wide range of excitation magnetic field to be achieved with high resolution. Optimizations on the shape of detection coil and sample increased the sensitivity in DC susceptibility measurement. The proposed harmonic detection technique for DC susceptibility measurement was effective in improving the signal-to-noise ratio. A compensation coil technique was implemented during fabrication of detection coil for AC susceptibility measurement to archive effective reduction in interference signal from excitation magnetic field and compact integration of AC/DC detection coil. As a result, a sensitivity of 3×10^{-10} Am^2 was shown by the developed system. This thesis culminates with two demonstrations of the developed system in a non-destructive evaluation of moisture content in mortar and a characterization of magnetic moment distribution in low-concentration solutions of magnetic nanoparticles for bio-medical applications. The separation of magnetic properties in mixture materials was successfully achieved with high sensitivity in both applications. The developed system can be expected as a powerful instrument for explorations of magnetic properties and non-destructive tests in future.

論文審査結果の要旨

研究内容は超伝導量子干渉素子(SQUID)を用いた磁化率計の装置開発とその応用技術についてである。高温超伝導 SQUID を用いることにより，従来最も高感度である低温系 SQUID を用いた磁化率と同等の感度を，非常にコンパクトな装置で得られることに成功している。また，装置開発のみならずその応用として，イムノアッセイの次世代計測法として用いる磁気ナノ粒子の水溶液中の磁気特性など，新しい評価法などを開発している。これらの研究成果は国際的にも認められたものであり，学位に十分ふさわしい優れた内容と判断する。