High-sensitivity multifunctional spinner magnetometer using a magneto-impedance sensor

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A novel spinner magnetometer was developed with a wide dynamic range from 10^{-10}–10^{-4} Am^2 and a resolution of 10^{-11} Am^2. High sensitivity was achieved with the use of a magneto-impedance (MI) sensor, which is a compact, sensitive magnetic sensor used industrially. Its slow spinning rate (5 Hz) and the incorporation of a unique mechanism for adjusting the spacing between the sensing unit and the spinning axis allows the measurement of fragile samples sized 10–50 mm. The sensor configuration, in which a pair of MI sensors is connected in opposite serial, along with an amplification circuit with a programmable low-pass filter, reduces the problems of external noise and sensor drift. The signal, with reference to the spinning frequency, is detected with a lock-in amplifier. The MI spinner has two selectable measurement modes: the fundamental mode (F mode) and the harmonic mode (H mode). Measurements in the F mode detect signals of the fundamental frequency (5 Hz), in the same way as conventional spinner magnetometers. In the H mode, the second (10 Hz) and the third (15 Hz) harmonic components are measured, in addition to the fundamental component. Tests in the H mode were performed using a small coil and a natural sample to simulate dipoles with various degrees of offset. The results revealed that the magnitude of the fundamental component of the offset dipole was systematically larger (by several percent) than that of the non-offset dipole. These findings suggest that this novel MI spinner will be useful in estimating the inhomogeneity of the magnetization of a sample that can equivalently be described by an offset dipole.

キーワード：スピナー磁力計、磁気インピーダンスセンサー、双極子モーメント、非双極子モーメント
Keywords: spinner magnetometer, magneto-impedance sensor, dipole moment, nondipole moment

