

Development of High-Resolution TMR Sensor Device for Application of Bio-Magnetic Field Measurement

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Bio-magnetic field applications have been expected for many years to the functional diagnosis of a human body. A diagnostic device with superconducting coil to diagnose epilepsy is an application example¹⁾. High-sensitive magnetic sensors which operate at room temperature without liquid Helium have been expected as next-generation magnetic sensors in order to expand the scope of application of bio-magnetic field measurement devices.

We are developing Tunneling Magneto Resistance (TMR) sensors with the aim of bio-magnetic field measurement and have developed a sensor device which can detect tens of pico Tesla of magnetic cardiac field (MCG) in low frequency band (Fig.1)

Noise reduction of TMR sensor device is important as same as improvement of the response to the magnetic field of the TMR sensor to obtain high magnetic field resolution. Therefore, Magnetic tunnel junctions (MTJs) coupled to soft magnetic layer for high magnetic sensitivity were connected series and parallel to reduce noise of the MTJs. 150% TMR ratio and about 5 Oe anisotropy field (H_k) near saturation range of magnetic property were observed with the arrayed MTJs (Fig.2). In addition, low noise analog amplifier especially in low frequency band was developed to reduce system noise. (Fig.3)

We are studying to apply more high magnetic responsive materials to the sensor device for detecting bio-magnetic field of brain in the near future²⁾ (Fig.4).

Acknowledgment

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Reference

- 1) R. Sakuraba et al., Clinical Neurophysiology, 127 (2016) 179-186
- 2) D. Kato et al., Applied Physics Express, 6 (2013) 103004

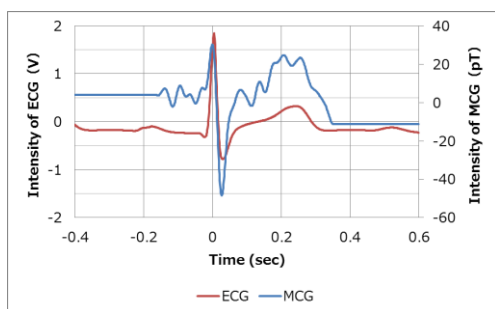


Fig. 1. Waveform of MCG and ECG

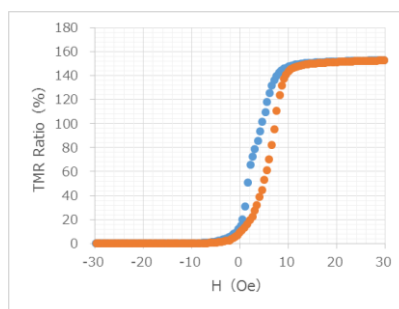


Fig. 2. R-H curve of MTJs with NiFe

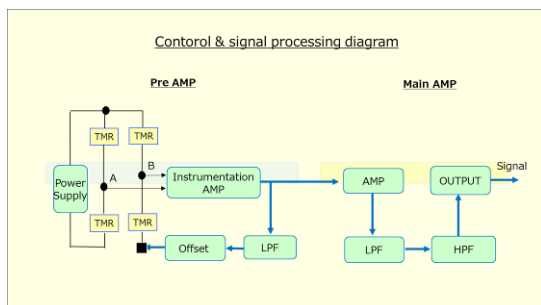


Fig. 3. Circuit block diagram

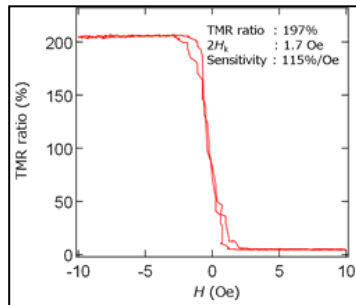


Fig. 4. R-H curve of MTJ with CoFeSiB