Development of pT resolution magnetic sensor utilizing MI element towards medical use

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Magnetization dynamics by pulse excitation in amorphous wire is limited in the surface layer by skin effect due to magnetic rotation. We have constituted highly sensitive linear micro magnetic field sensors utilizing Off-diagonal Magneto-Impedance (MI) effect. Recently we have succeeded in producing pico-Tesla (10^{-8}Oe) resolution MI sensors due to ultra-low intrinsic magnetic noise of amorphous wire [1].

Superconducting quantum interference deice (SQUID) have ultrasensitive, which have been utilized for bio-magnetic signals. For example, magnetocardiography (MCG) is a noninvasive technology that measures the magnetic field of the heart. It was developed for general-purpose use as a noninvasive, noncontact diagnostic tool for detecting obstructive coronary artery disease (CAD), and especially for detecting cardiac ischemia. Recently, MCG study using highly sensitive magnetic sensors, which can operate at room temperature, have been reported [2),3)].

We have tried to measure MCG signal using MI gradiometer. Fig.1 shows magnetic signal along with ECG sensor at 4 cm left the pit of the stomach. The subject was a man. A distance between from sensor head to a body surface is about 3 mm. The magnetic signal shown was averaged for ten times. The magnetic wave form was confirmed that is similar to the ECG wave form. By contacting sensor head to on shirts we recorded cardiac magnetic field of premature ventricular contraction as shown in Fig.2.

The SQUID has been also used to measure the human brain. The application of brain signals detection was developed in various fields. In medicine area, it could be implemented in such as brain injury inspection, diagnosis of neocortical epilepsy, telemedicine or cognitive functions research. And with advances in sensing technology, neuroprosthetics applications based on brain computer interfacing (BCI) could be improved and used to restore damaged hearing, sight or movement.

Event-related potentials (ERP) is one of the important biosignals of the brain which has a wide application in examining brain activity and cognitive functions. The P300 (or P3) is one of the ERP components which normally elicited in the process of making decisions. We have recorded of the waveforms of mean P300 magnetic field in occipital region elicited by audio stimuli, for several subjects. Brainwave measurement results of MI sensor will be presented and the results will be compared to SQUID's or EEG's results.

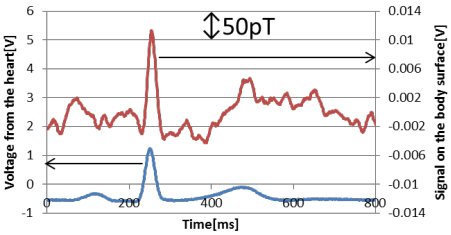

Fig.1.Voltage from the heart and Signal on the body surface at 4cm on the left of the pit of the stomach.

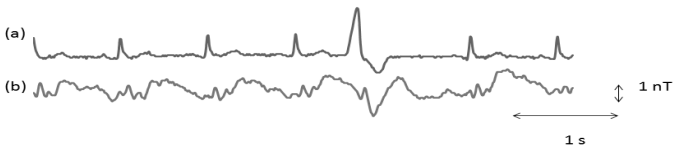

Fig.2. Recorded premature ventricular contraction of ECG in (a) and MCG by MI in (b).

Reference

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