First-order Wire-wound SQUID Gradiometer System Having Compact Superconductive Connection Structure between SQUID and Pickup Coil

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In order to have a Superconductive connection between the wire-wound axial gradiometer and input coil, typically Nb terminal block with screw holes is needed. Since this connection structure occupies large volume, large stray pickup area can be generated which can pickup external noise fields. Thus, SQUID and connection block are shielded inside a superconducting tube, and this SQUID module is located at some distance from the distal coil of the gradiometer to minimize the distortion or imbalance of uniform background field due to the superconducting module. To operate this conventional SQUID module, we need a liquid He level high enough which shortens the refill interval. To make the fabrication of gradiometers simpler and refill interval longer, we developed a novel method of connecting the gradiometer coil into input coil. Gradiometer coil wound of 0.125-mm diameter NbTi wires were glued close to the input coil pads of SQUID. The Superconductive connection was made using an ultrasonic bonding of annealed 0.025-mm diameter Nb wires, bonded directly on the edge of NbTi wires where insulation layer was stripped out. The reliability of the Superconductive bonding was good enough to sustain several thermal cycling. The stray pickup area due to this connection structure is about 0.1 mm^2, much small than the typical stray pickup area using the conventional screw block method. By using this compact connection structure, the total length of the gradiometer bobbin is only about 20-30 mm longer than the baseline of the gradiometer. Based on this compact module, we fabricated 61 first-order axial gradiometers. The gradiometers have a coil diameter of 20 mm, and the baseline is 70 mm. The 61 axial gradiometer bobbins were distributed in a hexagonal lattice structure with a sensor interval of 26 mm, measuring dB_z/dz component of magnetocardiography signals.

Keywords: SQUID, gradiometer, magnetic shielding, magnetocardiography