Improvement of the Sensitivity at Cryogenic Temperature of the Optical Fiber Sensor and Its Durability Evaluation

Motohiko SUGINO Katsutoshi MIZUNO Masafumi OGATA

To put the high-temperature superconducting (HTS) magnets to practical use, it is effective to detect a sign of failures by the temperature monitoring. It should be noted that the quench protection of HTS magnets is difficult. Temperature is distributed over HTS magnets when they are cooled by conduction cooling. Therefore, reliable multipoint temperature monitoring method is necessary. Unlike the conventional resistance temperature sensor, the optical temperature sensor can measure multipoint temperatures with a single fiber. The optical fiber is not affected by the fluctuation of the magnetic field and has low heat intrusions. A Fiber Bragg Grating (FBG) is a type of the optical fiber temperature sensor, but its accuracy of the measurement decreases at cryogenic temperature. Therefore, it has been proposed to coat the FBG sensor with a metal or a resin to increase the accuracy at cryogenic temperature.

Zinc is suitable for the coating material, because it has a high thermal expansion rate and its coating process is simple. Three types of zinc coating methods were evaluated in this research: sputtering zinc, electroplating zinc after sputtering titanium and copper, electroplating zinc after electroless nickel plating.

The FBG sensors coated by these zinc coating methods were compared with respect to the sensitivity at cryogenic temperature, the durability against vibration and thermal shock, and the repeatability of the cooling cycle. We report these results.