

Development of Zinc Coating Methods on Fiber Bragg Grating Temperature Sensors

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Abstract — To make practical use of the high-temperature superconducting (HTS) magnets, it is effective to detect a sign of failures by the temperature monitoring, because HTS magnets have temperature distribution when it is cooled by conduction cooling. Therefore, reliable multipoint temperature monitoring method is necessary. The optical temperature sensor can measure multipoint temperatures with a single fiber. The optical fiber is not affected by the fluctuation of magnetic field and has low heat invasions. A Fiber Bragg Grating (FBG) is a type of the optical fiber temperature sensor. When the FBG sensor thermally contracts, the refractive index of it changes and the wavelength of the light reflected from it changes. The thermal expansion rate of an optical fiber decreases at cryogenic temperature. Therefore, the accuracy of the measurement also decreases. It has been proposed to coat the FBG sensor with a metal or a resin to increase thermal contraction at cryogenic temperature. Zinc is suitable for the coating material, because it has high thermal expansion rate and its coating process is simple. Three types of zinc coating methods were evaluated in this research: sputtering, electroplating after sputtering titanium and copper, electroplating after electroless nickel plating. The production cost of these methods was evaluated. These zinc-coated FBG sensors were compared in the sensitivity at cryogenic temperature, the durability against vibration and thermal shock, the repeatability during the cooling cycle. We report the evaluation results of the zinc coating method on the optical fibers as a cryogenic temperature sensor.

Keywords (Index Terms) — Coatings, cryogenics, optical sensors, superconducting magnet, temperature sensors.