Development of a new electric power device that enables the grid-connection of numerous distributed generators

Low-loss superconducting thin-film fault-current limiter elements that immediately suppress short-circuit currents

Recent awareness of global warming has prompted the connection of numerous distributed generators, such as cogeneration systems and wind turbine generators, to the existing power grid, sometimes causing significant increase in short-circuit currents. Introduction of a fault current limiter (FCL) is considered an attractive countermeasure to such increased short-circuit currents. We have developed 500 V/200 A superconducting FCL modules using large high-temperature superconducting (HTS) thin films with high-resistivity Au-Ag alloy shunt layers, which can withstand high electric fields (E > 30 V/cm). Two HTS thin films on sapphire substrates (2.7 cm × 20 cm), prepared with a metal organic decomposition method, were used to fabricate such FCL modules. Switching tests using a short-circuit generator confirmed good current limiting properties. The required length of expensive HTS thin films has become less than one-fourth of that for conventional thin-film FCL modules that use gold shunt layers. It is expected that compact and low-loss thin-film FCLs can be realized with much reduced costs.

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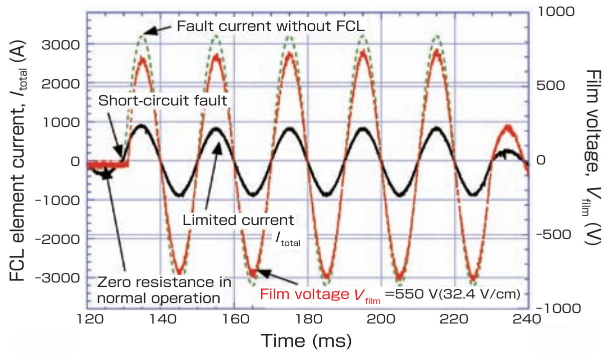

Switching test results using a short-circuit generator

Photon number discrimination with a superconducting transition edge sensor

New photon detection technique for realizing ultimate performances in quantum communication and metrology

I have developed a photon number resolving detector with superconducting transition edge sensors (TESs). The TES is a kind of calorimeters measuring the energy of incident photons as the increase of phonon temperature in a thin film absorber. The temperature rise also affects an electron temperature in the TES film resulting in the TES resistance change. The resistance change is proportional to the energy of incident photons. I have fabricated the TES devices with a thin film titanium superconductor embedded in an optical cavity to enhance the quantum efficiency. The titanium film has a relatively high transition temperature around 400 mK. With the illumination of weak coherent light pulses the fabricated device exhibited high quantum efficiency, fast response, and clear photon number discrimination up to 6 photons. TES-based photon number resolving detectors are quite promising for improving the performances of quantum communication and quantum optical radiometry.

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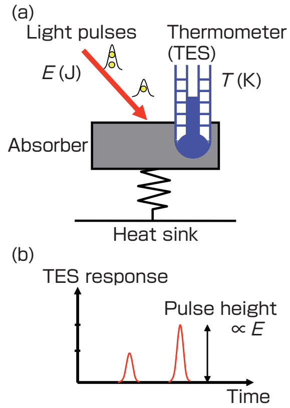

(a) Schematic diagram of the photon number resolving detector with the transition edge sensor (TES)
(b) Example of TES response signals to light pulses