MICRO COIL FABRICATION FOR UBIQUITOUS POWER MONITORING

Y. Zhang[1,2], S. Uchiyama[1,2], D. K. Lee[2], H. Hiroshima[2], T. Itoh[1,2], R. Maeda[2]
[1]BEANS NEDO Project, Macro BEANS Center, Tsukuba, Ibaraki, Japan
[2]National Institute of Advanced Industrial Science and Technology (AIST), Tsukuba, Ibaraki, Japan

Abstract

This paper presents our recent progress on the microfabrication technology of micro coil for ubiquitous power monitoring. Electromagnetic simulations and experiments demonstrated that micro solenoid-type inductor is attractive for the current sensing and thus power-consumption monitoring application. A three-dimensional photolithography technology and equipment are successfully developed for the low-cost fabrication of micro solenoid coil structure. A so-called cylinder projection lithography is also introduced in this work.

Introduction

The electricity power consumption of ICT technology is increasing enormously with the application of more ICT devices such as servers, network equipments, displays and etc. The electricity consumption of ICT devices is estimated to grow to be 20% of total generated electricity power in the year 2025. In Japan, the electricity consumption of ICT devices would increase by about 4.2 times by the year 2025. The energy consumption of internet data center (IDC) is also rapidly increasing with the increasing amount of data traffic on the internet. It is estimated to grow by two orders of its present value by the year 2025. Therefore, ICT technology needs new energy management technology for reducing the emission of CO_2. This research aims to develop a wireless sensor node for the power management of IDC, office and home. The sensor node is not only for monitoring the electric current flow in appliance cord but also for power generation by the alternating magnetic field surrounded so that it could be cheaper and maintenance-free.

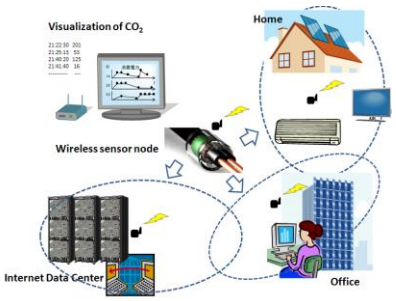

Fig. 1 Conception of wireless sensor-based power consumption monitoring system for ICT devices.

Design and experimental

Electromagnetic simulation and experiments were carried out for discussing the miniaturization of the sensor node based on micro solenoid inductor. The good fit between the simulation and experimental results on the induction voltage of a commercial meso-scale inductor, suggested that energy scavenging is even possible at low AC frequency by using micro solenoid inductor.

Three-dimensional and cylinder projection photolithography were developed for the fabrication of micro solenoid coil structure. Figure 2 shows schematic of the three-dimensional photolithography process and its continuous exposure mechanism [1].

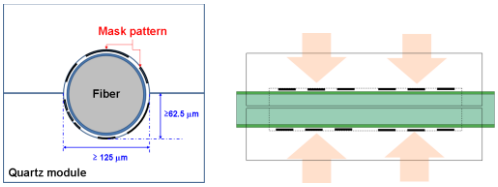

***Fig. 2** Schematic structure of exposure module with resist-coated fiber inside. Continuous lithography could be realized through step-forward movement of fiber and alignment process.*

Results

Preliminary photolithography experiments were performed by using 125 μm-in-diameter fiber. Thin resist film was deposited on the fiber and exposure by a MEMS-based exposure module under a conventional contact aligner. The MEMS-based exposure module was made of quartz and with fine Cr patterns prepared by projection photolithography method. It was confirmed that fine patterns could be transferred onto the fiber by using the prepared exposure module. Based on the results, an automatic exposure system was successfully developed.

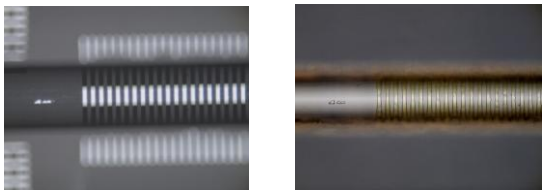

***Fig. 3** Cr patterns of the MEMS exposure module (left figure) and formed line patterns of resist on125 μm-in-diameter fiber (right figure).*

References

[1] Y. Zhang, J. Lu, A. Mimura, S. Matsumoto, T. Itoh, "MEMS-based exposure module for continuous lithography process on fiber substrates", Proceeding of IEEE MEMS 2010, Hong Kong, Jan.24-28, 380-383 , (2010).