Overview of G-device Project for Green Innovation at Center Kansai

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INTRODUCTION

The project objective is development of advanced sensor modules, experimental evaluation of practical sensor network system and establishment of manufacturing processes with low environmental impact, for energy savings and reducing of carbon emissions as the Green Innovation. The experimental evaluation of the project is intended for MEMS fabrication clean room. At Center Kansai, six research themes (1)Green Operation on demand (GOOD) for clean room, (2)Wireless Smart Multi-sensor Devices, (3)Development of Pollution Gas Sensors, (4)Real-time Position Tracking System, (5)Ferroelectric Thin Films for MEMS Sensors and Actuators, (6)Development of Eco-friendly Process Technology with Polymer, have been carried out. The related structure of research themes and experimental evaluation for MEMS clean room is shown in Fig. 1.

RESEARCH THEMES

(1) Green Operation on Demand (GOOD) for Clean Room

Sensor network can be realized "Clean on Demand" in a clean room through measurements at numerous points and significant energy savings. A sensor network is constructed to reduce CO_2 emission from a clean room. Optimize energy is controlled as maintaining quality by multi-point measurements, dust particles, FFU speed, air temperature, humidity, water temperature, exhaust air flow, gas flow, etc.. Smart Air Conditioning System (Clean on Demand) has been achieved by continuous measurement of particles and multi-point measurement of temperature and humidity.

(2) Wireless Smart Mmulti-sensor Modules

Miniature wireless sensor modules have been developed to be used in a clean room. Monitoring of environment and detecting events are carried out by the wireless smart multi-sensor modules to reduce energy consumption. An outer size of the module is as small as 3cm x 3cm x 1cm with three sensor-ports, RF circuit, CPU, and Battery. The modules can monitor of temperature, humidity, illumination, pressure, air-flow, acceleration, and more. 50 to 100 set modules can operate in a system. On a single charge, operation of 660 hours can be operated with measurement interval of 10 minutes.

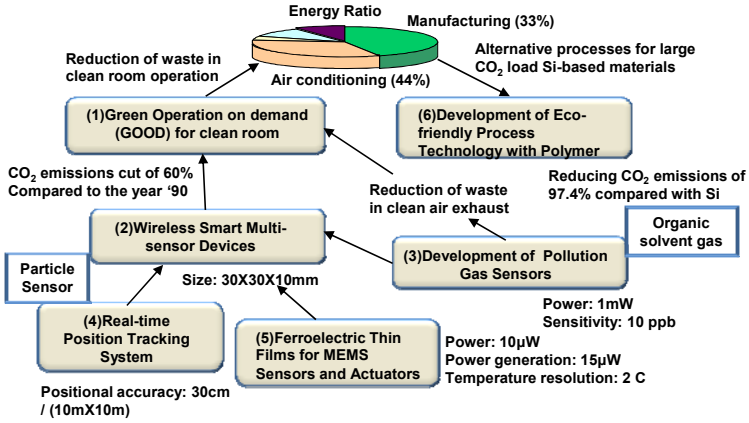

Fig.1 Experimental evaluation of the project is intended for MEMS clean room.

(3) Development of Pollution Gas Sensors

Low-power and high-sensitivity WO_3 gas sensors which can detect pollution gases (acid and alkaline gases) in ppb level in a clean room have been developed. The gas sensors contribute to the energy saving in a clean room by the draft exhaust control. By the control of the exhaust fan of the draft chamber according to the concentration of the pollution gases, not only the power consumption of the exhaust fan but also the power consumption concerning the clean air production is reduced.

(4) Real-time Position Tracking System

Shoes' heel-attached position tracking module to track persons in a clean room has been developed. Operators' locations are detected and displayed on Lab VIEW® screen. - A module is contained MEMS inertia sensors, RFID reader, RF module, CPU, battery and contactless charging unit. Inertia sensors send data for estimating positions, and its error is calibrated by using RFID. Nine persons can be tracked simultaneously. Three axis accelerometer and three axis gyroscope are embedded along with a RFID reader. Sensors are monitored every 10ms, data are transmitted every 100ms to the server. Around 20 parameters are to be used in calculations for one module.

(5) Ferroelectric Thin Films for MEMS Sensors and Actuators

Ferroelectric thin films for pyroelectric sensors and energy harvesting devices have been fabricated by sputter technique. Development of fabrication technique for ferroelectric thin films has been carried out formation of lead-free ferroelectric $BaTiO_3$ thin films by sputtering and transformation of ferroelectric films on glass and polymer substrate. Lead-free $BaTiO_3$ film showed high pyroelectric coefficient. PZT films with perovskite structure were successfully transferred on glass substrates by laser lift off technique.

(6) Development of Eco-friendly Process Technology with Polymer

Fabrication process with nano-imprinting method and the simulation techniques have been developed in order to establish the future polymer MEMS device technology. The polymer MEMS fabrication process is respected low driving voltage, high reflectivity, small surface roughness, and biocompatibility. Fabrication process of PMMA comb-drive actuator utilizing imprinting methods has been developed. The vertical comb actuator was operated well and the mirror plate could rotate about 10 degrees at 100V at 300Hz applied consecutively to the left and right actuators at two edges of the beams. And reflectivity of micro mirror was 93.4% at 1000nm.

SUMMARY

The development of advanced wireless smart multi-sensor modules, practical sensor network system and establishment of manufacturing processes with low environmental impact, for energy savings and reducing of carbon emissions will be conducted continuously until March 2011. The results of this project will be able to believe that the major contribution to saving energy and reducing emissions of carbon dioxide in the air conditioning at clean rooms and advanced production lines of the most energy-wasting. The consumption of carbon dioxide polymer MEMS process technology has become much smaller than that of silicon. It is expected to be able to create a sustainable production system in the near future.