●Basic Stage

(Fiscal Year 2007–2009)

Yokohama Inland Area

Rapid Manufacturing and Functional Evaluation of 3D Microsystems based on Nano-Micro Material Engineering and Optical-Image Measurement Technology

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Life Sciences
IT
Environment
Nanotech Materials
Others

Framework for Project Promotion

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Core Research Organization

Yokohama National University Graduate School of Engineering

Major Participating Research Organizations

Industry···JMC Inc., ASPECT Inc., Flowtech Research Inc., Plastic Engineering Research Inc., CMET Inc.
Academia···Yokohama National University
Government···YOKOHAMA CITY CENTER FOR INDUSTRIAL TECHNOLOGY 0& DESIGN

Aims of Project

In this project, the City of Yokohama aims to merge the fundamental R&D technologies of Yokohama National University, a leader in the area of establishing 3D microsystems and functional analysis, with the cutting-edge technologies of companies located in inland Yokohama, in fields such as laser stereolithography, powder sintering, and 3D precision machining. The aim is to establish next-generation rapid manufacturing technologies that can handle the entire manufacturing process from design to prototyping, measurement, evaluation, and manufacturing, and to create new industries such as high-added-value microsystems, tailored medical devices, and highly functional sensors and devices.

To realize these aims, the City of Yokohama plans to establish a global center in Yokohama for the manufacture of 3D microsystems and their functional evaluation. By advancing micro-manufacturing technologies in Japan, the project will contribute to the maintenance and enhancement of the international competitive edge of manufacturing technologies in this country. At the same time, related technologies will become concentrated in Yokohama to create an efficient manufacturing center that boasts sophisticated technologies, local industry will be enhanced, and technological infrastructure reinforced, thereby contributing to realizing the “Intellectual Mecca Yokohama” vision that is the current focus of the City of Yokohama.

Contents of Project

1. Development of a Rapid Micro-Manufacturing and Shape-Evaluation System

We intend to develop a high-precision powder sintering machine for the development of high-definition models. We will also investigate model materials for realizing high-precision micro-scale casting with a rapid turn-around, and attempt to cast using metals other than aluminum. Prototype 3D microsystems will be developed using a laser stereolithography method, powder sintering method, and rapid turn-around casting method. Shape evaluation will be performed for the respective methods, with the aim of developing and applying rapid fabrication-evaluation systems capable of high-precision measurements of 3D shapes at the micro level.

2. Development of a Fluid-Function Evaluation System for Microsystems

We aim to develop a measurement and evaluation system for fluid behavior in microdevices such as microreactors. Based on multidimensional fluid-measurement technology using non-contact high-resolution optical images, we will establish “on-the-spot observation and measurement technology” for microfluid behavior. Methods will be developed to enable the use of tracer particles and florescent dye; we will review the application of tracer particles to microflow measurements. In tandem with the development of these measurement technologies, we will establish numerical analysis techniques, applying the 3D shape data obtained during the modeling process.

3. Development of a Highly Functional 3D Micromachine System based on Nano-Microstructure Control and Light Control

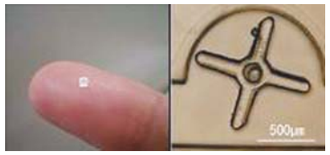
This project aims to develop a technique to fabricate highly functional hybrid micro-3D structures by applying metals, metal composites, and organic composites to state-of-the-art laserstereolithography techniques. This technique will help to realize the application of various properties of metals (e.g., mechanical properties, magnetism, rigidity, conductivity, drug-resistance, optical properties, shape memory effects, magneto-optical functions) to micromachines. To enable the rapid optical evaluation of the characteristics of the developed technique, we aim to develop the fundamental technology required for real-time imaging spectroscopy.

Main Results

1. In developing the shape-measurement system, we designed and developed a turn-table system with adjustable tilt angle and control of rotation angle. Software was developed using a mounted reconstruction algorithm for 3D models by applying the optical volume-intersection method. We also determined the conditions required for visualizing and measuring the shapes of transparent 3D resin models fabricated by micro-laserstereolithography (e.g., solvent required to match the resin and refraction factor).

Digital Microscope Turn-Table System and Revised Screw Design

2. In developing a fluid-visualization measurement method for laserstereolithography resins, we succeeded in designing and building a micro-flowmeter using laserstereolithography resins. We also developed a micro-PIV system for evaluating the characteristics of the flowmeter. In order to measure flux and pressure simultaneously, we constructed a 3D micro-PTV system based around a high-speed camera, and designed and built the visualization and measurement platform for evaluating measurement accuracy.



External View of Micro-Flowmeter and Photomicrograph

3. In developing non-electrolytic plating technology for resins, we succeeded in forming ferrite plating on photocurable resin by constructing a new experimental system that automatically supplies the solution. In establishing a magnetic-optical micro-nano machine using organic radical crystals, we synthesized organic radical TTTA samples and succeeded in developing high-quality single crystals of both paramagnetic and non-paramagnetic crystals using the vacuum sublimation method.

Copper Plating and Ferrite Plating