●Development Stage

(Fiscal Year 2005-2007)

Southern Okayama Area

Development of Active Microreactor for progressive micro reacting process

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Life Sciences
IT
Environment
Nanotech Materials
Others

Project Promotion

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Core Research Organization

Okayama University

Major Participating Research Organizations

Industry…DAISO CO., Ltd., Photochemical Co.,Ltd ., Bizen Chemical Co. LTD., PLANET, INC ., KASEN INTERNATIONAL CORP ., and participating organizations for Micro-Manufacturing Okayama companies
Academia…Okayama University, Okayama University of Science , Mimasaka University, Fukuoka Women's University , The University of Tokushima, The University of Tokyo
Government…Industrial Technology Center of Okayama Prefecture

Aim of research and developement

In addition to small and middle-sized companies which possess super-precision-processing technology in shipbuilding, automaking and agricultural machinery industries, the world leading super-precision processing companies in the field of fiber spinning nozzles (spinnerettes), artificial bones, super-precision machine tools and so forth are located in Okayama. With these precision processing companies in the prefecture, Okayama prefecture is promoting the project of "Micro Monozukuri Okayama Sosei Jigyo" for aiming the world class micro manufacturing industrial cluster "Micro Manufacturing Okayama"

City Area Program is placed as the core project of Micro Manufacturing Okayama. We aim to develop "active microreactor" showing excellent reaction properties by combining chemical process and microactuator technologies. Furthermore, we also aim to apply the valuable active microreactors to the manufacturing process. Through this project, we try to construct continuous cooperation of industry-academia-government and create new business in this region.

Contents of research

The development of the design element technology of the microreactor and the development of the micro reaction process technology that uses it are made to cooperate organically to incorporate plural microreactors to one process to achieve a highly effective material process with the microreactor, and the research and development is promoted.

1. Development of design element technology
It focused on the important 'flow" and 'mixture" in the chemical process. The following are developed as a design element technology to reasonably solve phenomenon in the micro reaction process.

1-1 Development of active device
Development of device technologies with the drive control function and its incorporation to microreactor
1-2 Development of fluid analysis technology in microchannel
Establishment of microchannel design technique based on fluid analysis
1-3 Development of surface modification technology of microchannel
Reduction of the flow resistance of the reactor channel by the surface modification, reaction with the substrate, and prevention of the substrate element melting.

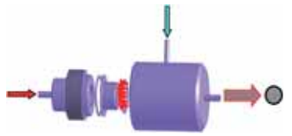
2.Development of micro reaction process technology
A fundamental reaction process of the synthesis, emulsification, the extraction, and combustion is referred here to use the design technologies as mentioned above and the microreactor based on the precise micromachining technology possessed by a regional enterprise. It also proposes the micro reaction process in which it aims at the application to a specific product manufacturing process.

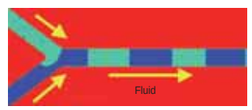
2-1 Micro synthesis reaction process: Manufacturing of non-natural-type amino acid and optically active lactone
2-2 Micro emulsification process: Manufacturing of emulsion preparation and macromolecule microcapsule
2-3 Microextractions process: Manufacturing of EPA and DHA high purity products
2-4 Micro catalytic combustion process: Development of highly effective micro catalytic combustion system for fuel cells.

The main study results

1. Development of practical "island in sea pattern confluence" type microreactor
"The confluent microreactor which has controlled cross section (island in sea pattern - confluence micro reactor)" was developed in the former research project. This microreactor has been improved in this project and developed fine structure having many sub mm size uniform holes. It is confirmed that the advanced reactor can generate more than 10 times of the specific interface surface area (m2/m3) between insoluble two solutions with comparing the proto type.

Appearance of practical sea-island inflow reactor


Structure of practical sea-island inflow reactor

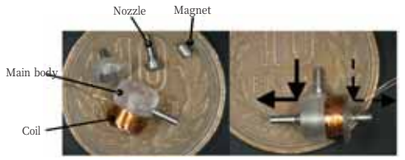


Sample of alternating flow simulation

Micro reactor parts for verification

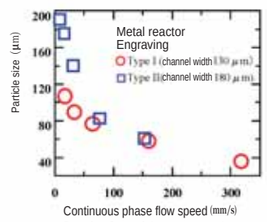
2. Development of fluid analysis in Y shaped micro-channel
The computational program to investigate the flow aspect of the two-phase flow in Y-shape micro-channel was developed. Using this program, the alternating flow having the interface expressed in high precision can be obtained under certain conditions.

3.Developement of various active fluid control devices
Various devices of pumps, valves, and shaking catalysts relating microreactor systems were designed and evaluated. For instance, a rotary pump without pulsation flow, a micro bellow pump, a plate-type valve, and a cylinder-type valve are developed.



Electromagnetic driven micro valve

4.Preparation of monodispersed O/W emulsions by microreactors
Monodispersed O/W emulsion was successfully prepared by using stainless steel microreactors (ex. groove type, slit type etc.). Diameter of the O/W emulsion was satisfactorily controlled in the wide range of the average diameter from 18.2 to 230 μm under 10 % in coefficient of variation by changing the microchannel structure, dimension, and flux of the continuous phase. These results suggest that the stainless steel microreactors possess the same potential for making emulsions as the other kind of microreactors.



Result of emulsion preparation