Optical-driven Nano Machines and Tissue Engineering Devices by Polymer-based 3D Micro/nano Fabrication Processes

Koji Ikuta

Department of Information Physics and Computing
Graduate School of Information Science and Technology
The University of Tokyo
7-3-1 Hongo, Bunkyo-ku, Tokyo, 113-8656, JAPAN

We have been developing “optically-driven micro/nano robotic devices” working in water. A real three dimensional micro fabrication process using photo curable polymer “micro/nano stereolithography “ developed by the author’s group is utilized. This process achieved 100 nm in 3D resolution and the freely movable micro/nano structures can be fabricated without any assembling or bonding process. Nano tweezers/needle with 2 D.O.F (degrees of freedom) and nano robot hand with 3 D.O.F. were successfully fabricated and verified to control. Several kind of “living celsl” and delicate biological materials can be remotely handled. The sub-pN range real-time force sensing system has been developed and force measuring ability during micro operation of living cell was succeeded. Mechanical property of the yeast cell and red blood cell were measured successfully. Theses results bring new aspect to cellular biology, because the mechanical data became more important in that leading edge. The optical-driven micro/nano tools should contribute to cellular biology as well as biomedical tools.

The another significant contribution of the newly developed 3D nano fabirication is the Tissue Engineering micro devices. The advanced biochemical IC chip-set for “on chip cell-free protein synthesis” and “Proteomic device” to analyze protein of the cells were developed. And poison-free process was found to utilize commercial photo curable polymers for cell-compatible devices.

Next, new 3D nano fabrication process named “MeME” process family has developed. This process can make a membrane-based micro fluidics and structure using biodigraleble polymers such as PLA. Various kinds of micro/nano devices for advanced tissue engineering have been developed. Some devices will be introduced.