Abstract of Dissertation

論文題目　High speed and highly sensitive biomolecule measurements
by MEMS based microdevices
（MEMS 技術による極微小デバイスを用いた生体分子高速・高感度計測）

Name: Hideyuki Arata　　氏名　新田　英之

To establish general purpose methods and tools for experiments in subsecond time scale is an essential requirement in future research in molecular biology such as protein folding-unfolding or denaturing properties because most of the functions of living organisms in molecular level take place in this time scale. The methods and the devices which realize experiments in sub-seconds time scale and also with high sensitivity of chemical detection were established by MEMS based top-down technologies. The micro-container for detecting enzymatic chemical activity in single molecule level was manufactured. Experiments of motor protein and enzymatic activities at 1 second time scale were performed by the micro-thermodevice of 400 μm in size. This resulted in rapid and reversible angular velocity control of F_1-ATPase, the motor protein. The torque of F_1-ATPase was measured to increase at higher temperatures with the increasing rate of 4 % per 10 ºC. Enzymatic activity measurements of β-galactosidase were performed at temperatures higher than that would normally denature them thanks to the rapid temperature alternation. Experiments of quenching measurements of DNA and proteins denaturing at the millisecond time scale were performed by the micro-thermodevice of 20 μm in size. This resulted in the first measurement of quenching dynamics of DNA which was measured to be around 10 ms. Green fluorescent protein (GFP) quenched with second order exponential decay with time constants of 4~10 ms and 70~130 ms. Besides the main advantages of high speed and highly sensitive chemical detection, these devices have the potential for shortening experiment hours by the other advantages such as mass production and potential for on-chip parallel assay. These devices are capable of handling any kinds of biomaterial; they do not require any mutations or biochemical treatment to the material itself, therefore, it is a device of general purpose. Further study with these devices and methods may give a break through of the research field in protein analysis in molecular level and act as powerful tools in molecular biology.