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Biocomplexity Faculty Search Committee
c/o Prof. Rob de Ruyter
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Dear Professor de Ruyter:

I am writing to apply for the faculty position in the area of microfluidics in Biocomplexity Institute at Indiana University, Bloomington. I am currently a postdoctoral scholar in the Department of Applied Physics, California Institute of Technology and learned of the position through your web site.

Since beginning my doctorate study in 1997, my research interests have been focused on microfluidics or integrated microbiosystems. I completed my Ph.D. in Chemistry and Biotechnology (Biochemical Engineering), School of Engineering at the University of Tokyo with the dissertation titled "Development of Microfabricated Genetic Analysis Systems". After completing my Ph.D., I worked at the Institute of Industrial Science, University of Tokyo from 2000 to 2001 as a postdoctoral research fellow. During that time I was involved in several research projects based on micro/nanofabrication, microfluidics, DNA/protein microarrays, and system integration. I also had a productive research experience at the Institute of Physical and Chemical Research (RIKEN), Saitama, Japan as a junior research associate with the research theme "Development of MicroBioProcessor Systems". I have also conducted research for several companies, including Hitachi Electronics Engineering Co. and Mitsubishi Chemical Co., regarding the development of microsystems for chemical/biochemical applications. All this collaboration led to several patents in microfluidic systems.

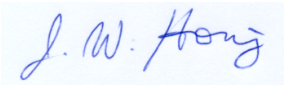
Since coming to the California Institute of Technology (Caltech) for my second post-doctoral study, I have been working on integrated microfluidic systems for molecular biology. As part of this work, I have published a review article in 'Nature Biotechnology' and another research article is under consideration by the same journal.

I have considerable mentoring experience both in the United States and abroad. I mentored more than 10 graduate and undergraduate students in Japan as well as an undergraduate here at Caltech who was awarded the 1st place Summer Undergraduate Research Fellow in 2002. Currently I am mentoring two graduate students. I am committed to working with my students and have maintained professional relationships with many of them years beyond the laboratory environment.

I believe that I would be an asset to your institute and department as well as to Indiana University, Bloomington as a whole and welcome the opportunity to discuss my potential contribution to your institute. Please find enclosed my curriculum vitae and a statement of research and teaching interests.

Thank you for your consideration and I look forward to hearing from you.

Sincerely,



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Statement of Research Plans

"Integrated Microfluidic Systems for Nanobiotechnology"

Jong Wook Hong, Ph.D.

Past and Current Research

My research is intrinsically interdisciplinary, uniting Engineering and Applied Science with Biology and Medicine. During my doctorate research I worked on the development of integrated systems for genetic analysis. As part of this work, I developed electrokinetic microfluidic devices for capillary gel electrophoresis that can be used for the separation of small biomolecules such as DNA, RNA, protein, etc., with dramatically improved resolution[1]. I also developed a micro genetic amplification device for the polymerase chain reaction (PCR), a procedure commonly used to amplify DNA by using thermal cycling[2]. Moreover, these two components were integrated onto a chip which was the first of its kind in polymer based devices. In addition to application research, fundamental research for microfluidics was carried out by using micro particle image velocimetry (□PIV)[3]. I have an extensive experience with various polymer substrates for MEMS processing of biomedical devices such as polydimethylsiloxane (PDMS), polymethylmethaacrylate (PMMA), and parylene in addition to silicon, glass and quartz.

For my postdoctoral study at Caltech, I have been working on integrated microfluidic systems for the isolation of target biomaterial, such as DNA, from tiny amounts of biological samples by using robust mechanical valves under pneumatic control. I also devised the first integrated nanoliter system with parallel architecture capable of complicated processing many parallel samples using the same total number of valve controls as a single sample[4]. This suggests that microfluidic systems can be applied to highly integrated parallel processes and high-throughput applications. Finally, I successfully carried out DNA isolation from less than 28 *E. coli* cells in a 400 picoliter sample volume improving upon conventional sensitivity by 4 orders magnitude.

Trends in Microfluidics

Microfluidic research for the last decade was focused on the development of single components such as valves, pumps, etc. Future microfluidic research will be focused on large-scale system integration for applications in biotechnology and nanotechnology[5]. Through the development of integrated microfluidic systems that carry out multiple functions, it is possible to broaden their use into new fields such as Biophysics, Biomedical Engineering and Materials Science, and Environmental Engineering, including *in situ* applications for space exploration and underwater development.

Future Goals

I am interested in a broad range of topics involving microfluidic integration and plan to continue building upon my experience in my doctoral study and two post-doctoral positions. The integration of nano/microfludic systems for nanobiotechnology and/or systems biology is an area I wish to explore more deeply. Some examples include: (1) High-throughput micro/nanofluidic systems for a series of biomedical analyses (2) Micro/nanofluidic bioreactor systems for single target cell culture (3) DNA/Protein microarrays integrated with microfludic systems for systems biology. In the above cases the unique ability of microfluidic systems to generate reagents from individual mammalian cells and small numbers of bacterial cells will enable the application of functional genomics and proteomics to previously inaccessible problems.

References

1. Hong, J.W., Hosokawa, K., Fujii, T., Seki, M., and Endo, I., "Microfabricated Polymer Chip for Capillary Gel Electrophoresis", ***Biotechnology Progress***, **17**, 958-962, 2001.
2. Hong, J.W., Fujii, T., Seki, M., Yamamoto, T. and Endo, I., "Gene Amplification and Electrophoretic Separation on a PDMS-Glass Hybrid Microchip", ***Electrophoresis***, **22**, 328-333, 2001.
3. Kinoshita, H. et al., "Micro PIV Measurement of Electroosmotic Flow", Proc. 6th Int'l Conf. of Miniaturized Chemical and Biochemical Analysis Systems (***microTAS2002***), 1, 374-376, 2002.
4. Hong, J.W., Studer, V., Hang, G., Anderson N. F., and Quake, S. R., "A Nanoliter Scale Nucleic Acid Processor with Parallel Architecture", ***Nature Biotechnology***, under review.
5. Hong, J.W. and Quake, S.R., "Integrated Nanoliter Systems", ***Nature Biotechnology***, **21**, pp. 1179-1183, 2003.

Statement of Teaching Plans

I would like to use teaching tools such as the direct projection of computer screens, interactive web notes and assignments. The use of interactive programs can tremendously improve the students' comprehension. I am eager to teach courses from one of the three categories below:

- *Advanced courses*: Advanced Nano/Microfluidic Systems, Advanced BioMEMS
- *Graduate/senior courses*: Nano/Microfluidics, BioMEMS, Nano/Microfabrication Laboratory, Microfluidics Laboratory, Biomedical Engineering, Biochemical Engineering, Bioprocess Engineering, Bioseparation Engineering, Molecular Biology, Microbiology
- *Undergraduate courses*: Biotechnology for Engineering, Introduction to Molecular Biology, Introduction to Immunology, Introduction to Biochemical Engineering, Introductory Chemistry, Introductory Biology, Introductory Biophysics, Introductory Immunology, Introductory Analytical Chemistry, Instrumental Analysis

Teaching Microfluidics and Bio-systems/BioMEMS is inherently challenging because those are interdisciplinary courses with state-of-the-arts technology, which evolves at a rapid pace. One must constantly evaluate the course content to keep it relevant and inspiring. The lecturer is a co-learner uncovering the underlying principles of the rapidly changing technological frontier. I look forward to meeting this challenge.