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CAREER GOALS:

To do creative and independent research,
to teach bioelectrochemistry and quantum mechanics to students, and
to help them become comfortable in the art of doing research

ACADEMIC AND TECHNOLOGICAL BACKGROUND:

Bioelectrochemistry: nanometer-sized biosensors and stimulators
Molecular electronics: switches based on molecular recognition
Cell biocomputing: communication between cells and solid state electronics

EDUCATION/EXPERIENCE:

12/2000 - present: Postdoctoral research scholar at Oak Ridge National Laboratory
(for chemical microtechnology group. Dr. J. Michael Ramsey)
11/1999 - 11/2000: Postdoctoral research scholar at California Institute of Technology
(Electrokinetics & Electrocatalysis lab. Prof. Fred C. Anson)

03/1997 - 10/1999: Researcher for Institute of Medical & Biological Engineering
Medical Research Center, Seoul National University
(Biological signal analysis lab. Prof. Hee-Chan Kim).

02/1993 - 02/1997: Ph.D. in electrochemistry and Molecular Recognition,
Seoul National University (Advisor - Prof. Hasuck Kim)
Ph.D. thesis title: “Development of Redox-Dependent Ionophores and Their Applications to Electrochemical Sensors".

02/1991 – 02/1993: M.S. in analytical chemistry, Seoul National University.

03/1987 – 02/1991: B.S. in chemistry, Seoul National University.

INTERESTS AND SKILLS:

I am interested in biosensors, bioelectronics and molecular recognition chemistry. My research experience includes various fields: 1) electron transfer in biomimetic components, 2) miniaturized enzyme electrodes for implantable biosensors, and 3) microfluidics for bioanalysis.

I have designed a novel self-assembled monolayer system of artificial ion-receptors and developed ionic recognizers and molecular deliverer under electronic control. I am skilled in fabrication/characterization of ion-selective electrodes, immobilization of various biological components such as enzymes on solid electrode supports, instrumentation for laser-induced fluorescence detection, instrumentation for biological research, fabrication/application of conducting/non-conducting electropolymerization, glass/silicon/polymer machining for microchip-based analyzers, handling nano-channels on solid chips, and integration of vertically aligned nanoprobes and living cells bio-hybrid chip.

AWARDS, HONORS AND ACTIVITIES:

1992-1995: Teaching Associate, general chemistry and analytical chemistry courses.

1997: Korean Research Foundation Postdoctoral Fellowship.

1999: Korean Science & Engineering Foundation Oversea-Postdoctoral Fellowship.

Professional Affiliations:

1991 – present, Member of the Korean Chemical Society, Electrochemistry Division

1995 – present, Member of the American Chemical Society, Analytical Chemistry Division

REFERENCES:

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RESEARCH INTERESTS AND PUBLICATIONS:

My previous work is summarized into the following four areas.

1) Combination between microfluidics and nanoprobes on microchips
2) Miniaturized biosensors
3) Molecular recognition and electrochemical control
4) Electron transfer kinetics at liquid-liquid interface

*A list of publications and presentations at international meetings are enclosed.

1) Combination between microfluidics and nanoprobes on microchips

J. Michael Ramsey's group at Oak Ridge National Laboratory is one of the representative pioneers of microfludics technology for chip-based microanalytical systems. My current projects include applications of nano-sized carbon probes vertically grown on the top of silicon wafers to bridge living cells to solid state electronic devices. Such patterned nanoprobes potentially act as unique I/O cards for bio-hybrid computers by applying chemical/electrical stimuli(input) and recognizing cell signals(output). Numerous creative combinations of bioelectrochemistry and microfluidics are conceivable to hybridize living cells and solid state integrated circuits through patterned nanoprobes. I am also involved in the development of automatic drug screening and cell counting in sub-nanoliter volumes at rates faster than 1 Hz. The microfluidic control technology is expected to revolutionize high throughput drug screening, and fabrication/analysis of nano materials. Specifically, non-intrusive velocimetry, amperometric detection method, and electrically driven field-free micropump were developed for biological applications of microchips.

Three papers of my works are to be published.

2) Miniaturized biosensors for glucose monitoring *in vivo*

My previous experiences also include the fabrication of needle-type enzyme-based sensors for continuous glucose monitoring for diabetes. Microelectromechanical system(MEMS) technology was of interest as new potential approach to devise chemical sensors and biosensors for clinical use. Microfabrication technology was applied to produce a microbiosensor array for collecting the information about changes of glucose concentration in biological media, especially in subcutaneous layer. The array of micrometer-sized biosensors with nanometer-thick enzyme membranes successfully works in human serum as well as in interstitial cellular fluids beneath skins. More than anything else, newly devised surface modification method opened the door toward nanobiosensors.

(1) Taek Dong Chung, Ran-A Jeong, Sun-Kil Kang and Hee-Chan Kim
"Reproducible Fabrication of Miniaturized Glucose Sensors: Preparation of Sensing Membranes for Continuous Monitoring"
Biosensors & Bioelectronics 16(9-12), 1079-1087 (2001).

(2) Hasik Yang, Yun Tae Kim, Taek Dong Chung and Hee-Chan Kim
"Glucose Sensor Using a Microfabricated Electrode and Electropolymerized Bilayer Films"
Biosensors & Bioelectronics in press (2001).

Submitted

(1) Taek Dong Chung, Ran-A Jeong, Sun Kil Kang and Hee Chan Kim
"Electropolymerized bilayer combining highly selective polymers and perfluorinated tetrafluoroethylene: Fabrication of continuous monitoring glucose sensors without using non-aqueous solvents"
Submitted (2001).

Patent filed

Inventors: Taek Dong Chung, Ran-A Jeong and Hee-Chan Kim
Assignees: Sooil Inc., Hee-Chan Kim and Soo-Bong Choi
Title: "Method for fabrication of biosensors"
Korean patent No. 99-44034

*The same technology is to be filed for a US patent.

3) Molecular recognition and electrochemical control

The chemical information of chemical species in biological fluids can be selectively converted into significant electrical signals by use of well-designed molecular assembly systems on solid electrodes. Electro-active functional macrocycles such as quinone-derivatized calixarenes, biscrown ethers and azophenols with crown ethers were proposed and synthesized. Such artificial receptors were immobilized onto gold, platinum, and carbon electrodes by a variety of methods: self-assembly, electropolymerization, doping in liquid-polymeric membranes as well as others. These systems let us possess the smaller and finer molecular injector and retriever than ever reported. I was invited to introduce the recent progress of this new field with a review article that was published as a cover story of an international molecular recognition journal in 1998.

Published

(1) Taek Dong Chung, Sang Kwon Lee, Young-Gu Ha, Ki Won Cha, Songju Lee, Kihyoung Cho and Hasuck Kim
"Electrochemical Behavior of MR19 and Its Complexes with Light-Lanthanides"
Bull. Kor. Chem. Soc. 14(5), 567-574 (1993).

(2) Dongsuk Choi, Taek Dong Chung, Sang Kwon Lee, Sun Kil Kang, Tae Hoon Kim, Suk-Kyu Chang and Hasuck Kim
"Electrochemical Recognition of Ammonium and Alkali Metal Cations with Calix[4]arenediquinone"
J. Electroanal. Chem. 387, 133-134 (1995).

(3) Taek Dong Chung, Dongsuk Choi, Sang Kwon Lee, Sun Kil Kang, Taehoon Kim, Suk-Kyu Chang and Hasuck Kim
"Electrochemical Behavior of Calix[4]arenediquinones and their Cation Binding Properties"
J. Electroanal. Chem. 396, 431-439 (1995).

(4) Sang Kwon Lee, Taek Dong Chung and Hasuck Kim
"Indirect Voltammetric Determination of Lanthanides in the Presence of Mordant Red 19"
Electroanalysis 9, 527-532 (1997).

(5) Taek Dong Jongseo Park, Suk Kyu Chang and Hasuck Kim
"New Potassium-Selective Electrode Based on an Ionophoreic bis(crown)s Derived from Xanthene-4,5-dicarboxylic Acid"
Anal. Sci. 13(S), 325-328 (1997).

(6) Taek Dong Chung, Sun Kil Kang, Jongwon Kim, Heesoo Kim and Hasuck Kim
"Interaction Between Various Alkylammonium Ions and Quinone-Derivatized Calix[4]arenes in Aprotic Media"
J. Electroanal. Chem. 438, 71-78 (1997).

(7) Yeon Hee Cho, Seung Gul Rha, Suk Kyu Chang, Taek Dong Chung, Keunchang Cho and Hasuck Kim
"New Potassium and Cesium Selective Ionophoreic bis(crown)s Derived from Xanthene-4,5-dicarboxylic Acid"
J. Inclu. Pheno. Mol. Recog. 31(2), 119-129 (1998).

(8) Weon Seok Oh, Taek Dong Chung, Jongwon Kim, Hee-soo Kim, Hasuck Kim, Dongmok Hwang, Kimoon Kim, Seung Gul Rha, Jong-In Choe and Suk-Kyu Chang
"Synthesis and electrochemical properties of calix[4]arene-triester-monoquinones"
Supramolecular Chemistry 9, 221-229 (1998).

(9) Taek Dong Chung and Hasuck Kim
"Electrochemistry of Calixarene and Its Analytical Applications"
J. Inclu. Pheno. Mol. Recog. 32, 179-193 (1998).

(10) Taek Dong Chung, Sun Kil Kang, Hasuck Kim, Joo Ryn Kim, Weon Seok Oh and Suk Kyu Chang
"Synthesis and Electrochemical Behavior of a New Water Soluble Ca2+-selective Ionophore Based on Calix[4]arene-triacid-monoquinone"
Chem. Lett. 1225 (1998).

(11) Dongsuk Choi, Sang Kwon Lee, Taek Dong Chung, Sun Kil Kang and Hasuck Kim
"Electrochemical Determination of Adsorption Isotherm of Mordant Red 19 on Mercury and Its Analyticlal Application for the Indirect Determination of Uranium"
Electroanalysis 12, 477 (2000).

(12) Hasuck Kim, Sun Kil Kang and Taek Dong Chung
"Ionic Recognition with Quinone-Derivatized Calixarenes in Solution and at Self-Assembled Monolayers"
J. Kor. Electrochem. Soc. 3, 69 (2000).

(13) Sun Kil Kang, Taek Dong Chung and Hasuck Kim
"Electrochemical Recognition of Ca2+ ion in Basic Aqueous Media Using a Quinone-Derivatized Calix[4]arene"
Electrochim. Acta 45(18), 2939 (2000).

(14) Hee-soo Kim, Taek Dong Chung and Hasuck Kim
"Voltammetric Determination of the pK_a of Various Acids in Polar Aprotic Solvents Using 1,4-Benzoquinone"
J. Electroanal. Chem. 498, 209 (2001).

(15) Jongwon Kim, Taek Dong Chung and Hasuck Kim
"Determination of Biologically Active Acids Based on the Electrochemical Reduction of Quinone in Acetonitrile/Water Mixed Solvent"
J. Electroanal. Chem. 499(1), 78 (2001).

(16) Jongseo Park, Sun Kil Kang, Taek Dong Chung, Suk-Kyu Chang and Hasuck Kim
"Selective electrochemical recognition of ions in solution and at self-assembled monolayers" *Microchem. J.* 68(2-3), 109-113 (2001).
(17) Hasuck Kim, Jandee Kim, Hyunchang Lim, Mi-Jung Choi, Suk-Kyu Chang, and Taek Dong Chung
"Electrochemical Recognition of Irons with Self-Assembled Monolayers of Quinone Derivatized Calixarene Disulfide"
In Studies in Surface Science and Catalysis 132, Y. Iwasawa, N. Oyama and H. Kunieda (Editors), Elesevier Science B. V., (2001).
(18) Taek Dong Chung, Jongseo Park, Hyunchang Lim, Hasuck Kim, Mijeong Choi, Joo-Ryon Kim and Suk-Kyu Chang
"Self-Assembled Monolayer of a Redox-Active Calix[4]arene: Voltammetric Recognition of Ba^{2+} Ion in Aqueous Media"
Anal. Chem. 73(16), 3975-3980 (2001).

To be submitted

(19) Kyungmin Chun, Taek Dong Chung, Hasuck Kim, Keiji Hirose, One-Sun Lee and Doo-Soo Chung
"Voltammetric Recognition of Chiral Amines Using Functionalized Acerands"
(20) Sun Kil Kang, Taek Dong Chung, Hasuck Kim, Joo-Ryn Kim and Suk-Kyu Chang
"Voltammetric Assay of Free Ca^{2+} ion in Aqueous Phase"

4) Electron transfer kinetics at liquid-liquid interface

Most of biological systems consist of numerous liquid-liquid interfaces that are immiscible by nature. Information flow across cell membranes is transmitted by proteomic receptors spotted on the oily membranes. This is one of the key biological processes sustaining vital systems. Voltammetric studies of electron-proton transfer across liquid-liquid interfaces provide valuable information concerning thermodynamic and kinetic principles. Even though the artificial system for faradaic process on solid electrode surfaces was already suggested decades ago, an effective way to trigger such electrocatalysis(signal amplification) has not been reported. Excellent catalytic electron transfer process in biological systems completely loses their activities when they are immobilized on solid electrode surfaces. In order to address this issue, a biomimetic system of liquid-liquid interface was designed and it was demonstrated that proton transfer across water-oil interface is fast enough to allow rapid electron flux within the oil phase in the presence of metalloporphyrins in spite of the high potential barrier of proton transfer in thermodynamic equilibrium. The principle underlying this study implies new concepts of DNA sensor array and proteomic chips.

Published

(1) Taek Dong Chung and Fred C. Anson

"Electrochemical Monitoring of Proton Transfer across Liquid/Liquid Interfaces on the Surface of Graphite Electrodes"

Anal. Chem. 73(2), 337 (2001).

(2) Taek Dong Chung and Fred C. Anson

"Catalysis of the Electroreduction of O_2 by Cobalt 5,10,15,20-tetraphenylporphyrin Dissolved in Thin Layers of Benzonitrile on Graphite Electrodes"

J. Electroanal. Chem. 505, 115 (2001).