

JOINT RESEARCH PROJECT

FINAL REPORT
For Japan-Korea Joint Research Project

AREA	1. Mathematics & Physics
	2. <u>Chemistry & Material Science</u>
	3. Biology
	4. Informatics & Mechatronics
	5. Geo-Science & Space Science
	6. Medical Science
	7. Humanities & Social Sciences

1. Research Title:

Development of Metallized DNA Nanodevice

2. Term of Research: From July 1, 2009 To June 30, 2011

3. Total Budget

a. Financial Support by JSPS: Total amount: 2400 thousand yen

1st Year 900 thousand yen 2nd Year 900 thousand yen

3rd Year 600 thousand yen

b. Other Financial Support : Total amount: 0 thousand yen

4. Project Organization

a. Japanese Principal Researcher	
Name	Satoshi Murata
Institution / Department	Tohoku University / Graduate School of Engineering
Position	Professor
b. Korean Principal Researcher	
Name	Sung Ha Park
Institution / Department	Sungkyunkwan University / Department of Physics & Sungkyunkwan Advanced Institute of Nanotechnology
Position	Assistant Professor

c. List of Japanese-side Participants (Except for Principal Researcher)

Name	Institution/Department	Position
Shogo Hamada	Tohoku University/ Graduate School of Engineering	Assistant Professor
Yoshinori Kimura	Tokyo Institute of Technology / Interdisciplinary Graduate School of Science and Engineering	Master Student
Satoshi Nishimoto	Tokyo Institute of Technology / Interdisciplinary Graduate School of Science and Engineering	Master Student
Kota Horiuchi	Tokyo Institute of Technology / Interdisciplinary Graduate School of Science and Engineering	Master Student
Toshikazu Taki	Tokyo Institute of Technology / Interdisciplinary Graduate School of Science and Engineering	Master Student

d. List of Korean-side Participants (Except for Principal Researcher)

Name	Institution/Department	Position
Rashid Amin	SKKU / Physics Department	Ph.D. Student
Ji Hoon Shin	SKKU / Physics Department	M&D Combined student
Junwye Lee	SKKU / Physics Department	M&D Combined student
Insoo Kim	SKKU / Physics Department	M&D Combined student
Sanjin Kim	SKKU / Physics Department	Master Student
Jae Kyung Jang	SKKU / Physics Department	Bachelor Student
Seungjae Kim	SKKU / Physics Department	Bachelor Student
Byeonghoon Kim	SKKU / Physics Department	M&D Combined student

5. Number of Exchanges during the Final Fiscal Year*

a. from Japan to Korea

*Japanese fiscal year begins April 1.

Name	Home Institution	Duration	Host Institution
For Final Fiscal Year(FY2011) Total: <u> 0 </u> persons		For Final Fiscal Year(FY2011) Total: <u> 0 </u> man-days	
Numbers of Exchanges during the past fiscal years			
FY2009: Total <u> 6 </u> persons			
FY2010: Total <u> 1 </u> persons			

b. from Korea to Japan

Name	Home Institution	Duration	Host Institution
For Final Fiscal Year(FY2011) Total: <u> 0 </u> persons		For Final Fiscal Year(FY2011) Total: <u> 0 </u> man-days	
Numbers of Exchanges during the past fiscal years			
FY2009: Total <u> 5 </u> persons			
FY2010: Total <u> 0 </u> persons			

6. Objective of Research

DNA-based nanotechnology has been attractive as a novel assembly method for fabricating nanostructures for the last two decades. A number of interesting DNA nanostructures with various dimensions have been designed and fabricated, but almost no realistic application of the nanostructures has been achieved yet. This joint research project aims at developing a novel fabrication method of metallization using electroless-chemical, physical, and functionalized metal ion depositions templated on DNA nanostructures for photoelectric sensor applications. Artificially synthesized DNA molecule is utilized as an excellent material, and desired nanostructure for device is self-assembled with designed base sequences of DNA molecule. Designing self-assembled DNA motif suitable for substrate-assisted growth and finding appropriate surface modification of the substrate are the main problems to study in this project. Also, photoelectric properties of the nanodevice will be examined to show the feasibility of proposed fabrication method. The project is divided into four items.

- 1) Preparation of patterned substrates using various polar/nonpolar organic layers
for electrostatic interactions between DNA and substrates
- 2) Fabrication of self-assembly of DNA nanostructure on the substrate
- 3) Metallization of the nanostructure based on electroless-chemical and physical depositions
- 4) Characterization of the photoelectric properties of the DNA-based nanodevices.

Both Tokyo Tech and SKKU have a potential in structural DNA nanotechnology, and will take part of all the items with close coordination. Cultivation of young generation researchers through the project is also expected.

7. Methodology

The following is planned methodology to execute the project described item-wise.

1) Preparation of patterned substrate

Making a selection of appropriate substrate material with proper surface charge density (e.g. silicone or graphite surfaces with some modifications with SAM, APS, and OTS). Also, appropriate top-down patterning method of the substrate will be investigated.

2) Self-assembly of DNA nanostructure on the substrate

Possible design of DNA motif with various geometries, which self-assembles only on the patterned area on the substrate for instance, APS covered substrates, will be investigated. Optimization of environment for substrate-assisted self-assembly will also be considered.

3) Metallization of the nanostructure

Method of selective metallization of DNA nanostructure will be investigated. Several possible methods (e.g. chemical process, sputtering, Metal-DNA etc.) will be considered.

4) Characterization of the photoelectric properties of the nanostructure

Photoelectric properties of metallized nanostructure (e.g. transmissive/reflective spectrum, etc.) will be examined. Based on the evaluation, a specific substrate pattern to demonstrate as a functional photoelectric sensor nanodevice will be designed and examined.