FINAL REPORT
For Japan-Korea Joint Research Project

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

1. Research Title:

Synchrotron Radiation Dark-Field Imaging (DFI) CT Microscopy Study for Microstructure Diagnosis and Photodynamic X-Ray Therapy

2. Term of Research: From 2009.7 To 2011.6

3. Total Budget

a. Financial Support by JSPS: Total amount: 2,400 thousand yen

1st Year 900 thousand yen 2nd Year 1,200 thousand yen

3rd Year 300 thousand yen

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

4. Project Organization

a. Japanese Principal Researcher	
Name	Masami Ando
Institution / Department Position	Research Institute of Science and Technology Tokyo University of Science Professor
b. Korean Principal Researcher	
Name	Jong-Ki Kim
Institution / Department Position	Catholic University of Taegu School of Medicine Professor

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

Name	Institution/Department	Position
Tadafumi Adschiri	Tohoku University/Institute of Material Science	Professor
Hiroko Bando	Tsukuba University Hospital/	Lecturer
Yoshinori Chikaura	Kyushu University/Center of Synchrotron	Professor
Tokiko Endo	Nagoya Medical Center/Department of Radiology	Head
Kazuyuki Hyodo	KEK/Photon Factory	Lecturer
Shu Ichihara	Nagoya Medical Center/Department of Pathological Survey	Head
Hiroshi Kihara	Kansai Medical School/School of Medicine	Professor
Toshiyuki Kunisada	Okayama University/School of Medicine	Associate Professor
Daisuke Shimao	Ibaraki Prefectural University of Health Sciences/ Department of Radiological Sciences	Research Associate
Hiroshi Sugiyama	KEK/Photon Factory	Research Associate
Kazuo Suzuki	Chiba University/School of Medicine	Professor
Fukai Toyofuku	Kyushu University/School of Medicine	Professor
Tetsuya Yuasa	Yamagata University/Faculty of Science	Professor

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

Name	Institution/Department	Position
Sang-Hoon Jheon	Seoul National University	Professor
Woong-Han Kim	Seoul National University	Professor
Bong-Il Kim	Catholic University of Taegu	Professor
Gi-Whan Choi	Catholic University of Taegu	Professor
Sung-Kyu Kim	Catholic University of Taegu	Professor
Sung-Whan Park	Catholic University of Taegu	Professor
Chang-Hyuck Choi	Catholic University of Taegu	Professor
Hong-Tae Kim	Catholic University of Taegu	Professor
Jung-Yun Hwang	Catholic University of Taegu	Professor
Ki-Hong Kim	Catholic University of Taegu	Professor

5. Number of Exchanges during the Final Fiscal Year*

*Japanese fiscal year begins April 1.

a. from Japan to Korea

Name	Home Institution	Duration	Host Institution
Masami Ando	Tokyo University of Science	6 days	Pohang Accelerator Laboratory and Seoul National University

For Final Fiscal Year(FY2011)	For Final Fiscal Year(FY2011)
Total: 1 persons	Total: 6 man-days

Numbers of Exchanges during the past fiscal years

FY2009: Total 7 persons
FY2010: Total 0
_____ persons

b. from Korea to Japan

Name	Home Institution	Duration	Host Institution

For Final Fiscal Year(FY2011)	For Final Fiscal Year(FY2011)
Total: 0 persons	Total: 0 man-days

Numbers of Exchanges during the past fiscal years

FY2009: Total 6 persons
FY2010: Total 11 persons

6. Objective of Research

Diagnosis of the microstructures associated with parenchymal pathology is essential for early diagnosis of cancer (brain, lung, breast, liver etc) or therapeutic efficacy of cancer as well as chronic obstructive pulmonary diseases (COPD) and rheumatoid arthritis. Present clinical imaging modalities suffer from inherent low spatial resolution compared to high resolving power as much as 10-50 micrometer which is required for early diagnosis.

In order to overcome this problem (A) a novel x-ray optics and (B) algorithm for reconstructing 3D image due to refraction has been developed since 1999. The x-ray optics (A) was named the x-ray dark-field imaging by which one can deduce pure refraction-based imaging directly without computer processing. This was achieved world first in 2002. (B) was also successfully achieved first in the world in 2005. Development of a new high spatial resolution *ex vivo* imaging with extremely high contrast that can visualize soft tissue is underway in a number of advanced synchrotron radiation facilities over the world. But till now none others except us can achieve internal soft tissue in 3D form.

Our study aims to realize imaging microstructures of brain glioma, lung cancer, COPD and rheumatoid arthritis using orthotopic animal model with novel set-up of CT synchrotron X-ray microscopy using DEI (diffraction-enhanced imaging) optics. Finally this study extends to investigate the photodynamic X-ray therapy of brain glioma, lung cancer *in vivo* models by combined using CT and metal nanoplatform targeted to tumor tissue.

7. Methodology

We developed 3D CT technique using X-ray dark-field imaging to be able to see soft tissue such as breast cancer, glioma, rheumatoid arthritis and lung cancer orthotopic model. This system comprises two crystals called a parallel arrangement of double crystal. Both of them are perfect FZ silicon crystals. The first piece is an asymmetric-cut crystal that has a size of 220mm x 70mm x 40mm. Its function is to make the outgoing beam almost parallel plane wave ~5/100 arc second. The second one is a Laue transmission angle analyzer with size of 70mm x 70mm x 1.5mm. Under this thickness two beams, the forward diffraction and the diffraction, have a maximum transmission. This transmission gives a maximum contrast for soft tissue. Also that this optics gives two beams at the same time may lead to a conclusion that in clinical application one needs only one exposure. This gives advantage over DEI that needs take 2 exposures in order to deduce refraction component. Still the beam size is not big enough if one goes to a real clinical application where 200mm x 200mm will be required. This problem will be soon solved by introducing CZ grown silicon crystals. Another significant medical approach is application to pathology where optical microscope is used. So that establishing x-ray pathology is our next goal. For this purpose we need more development of crystal system.