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:

Growth and optical study of fluoride crystals doped with rare earth ions :
Basic research for high quality optoelectronic devices

2. Term of Research: From 01.07.2006 To 30.06.2008

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	Taiju Tsuboi
Institution / Department	Kyoto Sangyo University/ Department of Computer Science
Position	Professor
b. Korean Principal Researcher	
Name	Hyo Jin SEO
Institution / Department	Pukyong National University / Department of Physics
Position	Professor

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

Name	Institution/Department	Position
Katsuyasu Kawano	University of Electro-Communications/ Department of Electronic Engineering	Professor
Byung-Ghul Hong	University of Electro-Communications/ Satellite Venture Business Laboratory	Research Associate
Katsuyoshi Sakamoto	University of Electro-Communications/ Department of Electronic Engineering	Assistant Professor

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

Name	Institution/Department	Position
Palamandala Babu	Pukyong National University / Department of Physics	Research Associate

5. Number of Exchanges during the Final Fiscal Year

a. from Japan to Korea

Name	Home Institution	Duration	Host Institution
Taiju Tsuboi	Kyoto Sangyo University	20.08.2006-27.08.2006	Pukyong National University
Taiju Tsuboi	Kyoto Sangyo University	02.11.2006-07.11.2006	Pukyong National University
Taiju Tsuboi	Kyoto Sangyo University	06.03.2007-12.03.2007	Pukyong National University
Taiju Tsuboi	Kyoto Sangyo University	15.08.2007-25.08.2007	Pukyong National University,
Taiju Tsuboi	Kyoto Sangyo University	13.01.2008-19.01.2008	Pukyong National University
Taiju Tsuboi	Kyoto Sangyo University	23.02.2008-26.02.2008	Pukyong National University
Taiju Tsuboi	Kyoto Sangyo University	24.04.2008-30.04.2008	Pukyong National University,
Katsuyasu Kawano	University of Electro-Communications	06.11.2006-08.11.2006	Pukyong National University
Byung-Ghul Hong	University of Electro-Communications	06.11.2006-08.11.2006	Pukyong National University
Total: 9 persons		Total: 56 man-days	

b. from Korea to Japan

Name	Home Institution	Duration	Host Institution
None			
Total: 0 persons		Total: 0 man-days	

6. Objective of Research

Rare-earth materials are important in many products that we use in our daily lives and they play an important role in many different types of optoelectronic devices. For example, emitters in displays of cathode ray tube TV and plasma panel TV, amplifiers in optical communication systems (e.g., Er-doped fiber amplifier), solid state lasers (e.g., Nd:YAG), and nanotechnology using rare-earth nanoparticles.

Regarding the display, high luminescent and highly efficient materials are requested together with the high color purity. The best candidate for high color-purity materials is rare-earth compounds because the trivalent rare earth ions give sharp emission lines at red, green and blue ranges. Most popular ion for red emission is Eu ions which gives emission about 615 nm. However, it is not clear which host materials give high efficient and long operation time for display.

Regarding the optical communications, the current amplifier system uses Er-doped fiber with 1550 nm. Er-doped materials with wide absorption and emission bands are requested for the broadband and high-bit C-band communication. In future we need another low-loss S- and L-band regions such as 1450 nm and 1600 nm, respectively, to achieve the high bit-rates. Tm ion has a possibility of 1450 nm communication. Also Er ion is also possible if we select suitable host materials. Materials with broad band absorption and emission spectra are necessary for not only the broad band communication but also high efficient diode-pumping.

Regarding the solid state lasers, powerful and efficient eye-safe lasers are currently requested. Such a near-infrared (at wavelength of 1300-2200 nm) laser is possible using ionic crystals doped with trivalent Ho, Tm and Er ions. Several materials have been investigated but the power is not enough. Calcium niobium gallium garnet (CNGG) crystal has several advantages because of its non-stoichiometric and disordered crystal structure. For example, broad absorption and emission bands which make possible more efficient diode-pumping for high-power laser action, large doping concentration which gives rise to high emission intensity. Therefore we study the near-infrared photoluminescence spectra of Er ions in CNGG crystals at 10-300 K.

Regarding the nanotechnology with rare-earth compounds, titania TiO_2 nanoparticle has been interested because it is useful for various applications such as solar energy conversion, battery, photoelectric chemistry and photocatalysis.Titania doped with rare-earth ions such as Er, Eu and Sm are also interested because of improvement of photocatalysis activity and enhancement of photoluminescence intensity from the doped rare-earth ions. The mechanism of enhancement of photocatalysis activity and luminescence intensity in the doped nanoparticles has not been clarified. Our project tries to give the detailed explanation for these unknown phenomena using the spectroscopy.

To improve the quality and emission efficiency, good rare-earth materials should be found for the above-mentioned three applications. This project was undertaken to search new rare-earth materials for optoelectronic devices and investigate the characteristics of the materials, and then to present the results for the optoelectronc engineers. Additionally we analyze the spectroscopic results by the physical background and explain why such an experimental result was obtained.

Two research groups in Korea (Prof. H.J. Seo, Pukyong National University) and Japan (Prof. T. Tsuboi, Kyoto Sangyo University) have long collaboration on the rare-earth spectroscopy and fruitful results. Based on such a good collaboration and experience, we synthesize rare-earth doped fluoride and oxide crystals and investigate their optical and luminescence characteristics.