GERMANY/HONG KONG JOINT RESEARCH SCHEME
THE PROJECT REPORT
(for Project Completion)

Project Number: 9053007
(G_HK008/10)

Title

Gels and Aerogels from Semiconductor Nanocrystals: Synthesis, Optical Studies and Evaluation of the Application Perspectives

Particulars

	Hong Kong team	German team
Name of Project Co-ordinator (with title)	Prof. Andrey Rogach	Prof. Alexander Eychmueller
Name of Co-Investigator (if any)	N/A	N/A
Institution or Institutional affiliation	[X] CityU [ ] HKU [ ] CUHK [ ] HKUST [ ] HKBU [ ] LU [ ] HKIEd [ ] PolyU	[X] Technical University of Dresden [ ] Others: _____
Other project team members (if any)	Dr. Andrei Susha	Prof. Dr. A. Eychmüller, Dr. N. Gaponik, Dr. V. Lesnyak, Mrs. A.-K. Herrmann, Mr. M. Müller

Funding Period

	1st year	2nd year (if applicable)
Start Date	01.01.2011	01.01.2012
Completion Date	31.12.2011	31.12.2012

Objective(s) as per original application

1. Solution-based assembly of light-emitting semiconductor nanocrystals into nanowires and their assembly into gels and aerogels
2. Optical spectroscopy studies of gels and aerogels
3. Evaluation of the applications aspects of gels and aerogels for light-emitting diodes and energy harvesting systems

etails of Report [Please attach relevant document(s)]

i) Outline of proposed research and results obtained

The proposed research of this collaborative project between two groups in Dresden and Hong Kong was on the fabrication of gels and aerogels based on strongly emitting semiconductor nanocrystals and on advanced optical characterization of the resulting nanostructured materials, in order to establish their key optoelectronic parameters, e.g. carrier transport rates and energy transfer efficiency, and to utilize them as building blocks for energy harvesting or for lighting applications. A number of composite materials have been fabricated and studied, including europium fluoride based luminescent hydrogels and porous cryogels, and crystalline $NaEuF_4$ and EuF_3 nanostructures. Advanced optical studies focused on different aspects of non-radiative Förster energy transfer between light-emitting semiconductor nanocrystals and gold nanoparticle layers.

ii) Significance of research results

The most significant results have been obtained on the mechanism of Förster resonant energy transfer (FRET) in semiconductor nanocrystal layers in close proximity to a monolayer of gold nanoparticles. At lower gold nanoparticle concentrations, localized surface plasmon mediated Förster resonant energy transfer enhancement of the acceptor emission was observed. At higher gold nanoparticle concentrations, the acceptor nanocrystal emission was reduced, despite faster localised surface plasmon enhanced Förster resonant energy transfer rates being achieved. This is attributed to competition between localised surface Plasmon mediated Förster resonant energy transfer and gold nanoparticle quenching effects. Good agreement with FRET theory has been found for nanocrystals with emission close to the localized surface plasmon resonance of gold nanoparticles.

iii) Research output

Results of this project have been published in high-level journals ACS Nano (2012) and J. Phys. Chem C (2012), and one paper has been submitted for publication in Mater. Sci. Eng. B in 2013:

1. X. Zhang, C. A. Marocico, M. Lunz, V. A. Gerard, Y. K. Gun'ko, V. Lesnyak, N. Gaponik, A. S. Susha, A. L. Rogach, A. L. Bradley. Wavelength, Concentration and Distance Dependence of Non-Radiative Energy Transfer to a Plane of Gold Nanoparticles. ACS Nano 2012, 6, 9283-9290

2. M. Lunz, X. Zhang, V. A. Gerard, Y. K. Gun'ko, V. Lesnyak, N. Gaponik, A. S. Susha, A. L. Rogach, A. L. Bradley. Effect of Metal Nanoparticle Concentration on Localized Surface Plasmon Mediated Förster Resonant Energy Transfer. J. Phys. Chem. C 2012, 116, 26529-26534

3. H. Wang, Y. Wang, J. Zhang, N. Gaponik, A. L. Rogach. Europium Fluoride Based Luminescent Materials: from Hydrogels to Porous Cryogels and Crystalline $NaEuF_4$ and EuF_3 Nanostructures. Mater. Sci. Eng. B., submitted.

iv) Potential for or impact on further research collaboration

The results obtained in this project pave the way for the future collaboration between the participating groups in particular in the area of optical sensing. Non-radiative energy transfer to metal nanoparticles is a technique used for optical based distance measurements which is often implemented in sensing, and this is the future direction we plan to explore.