Kwansei Gakuin University
Report of Research Outcome

2021/03/15

To President

Department : Science and Technology
Position : Postdoctoral fellow
Name : Li　Wang

I report the outcome of the research as follows.

Name of the Fund/Program	□Sabbatical leave with grant　□Sabbatical leave with no grant □KGU Joint Research　□Individual Special Research ⊠Postdoctoral fellow ※Please report by designated form as for "International Research Collaboration".
Research Theme	界面エンジニアリングによる高効率青色発光半導体量子ドットの合成とキャリア素過程
Research Site/Venue	Tamai Group
Research period	2020/10/01　～　2021/03/31　（　6　month）

◆ **Summary of the research outcome**　(approx. 2,500 words)
Please write down the outcomes in detail regarding the research theme above.

II-VI group zinc chalcogenide quantum dots (QDs) have high potentials in next-generation of opto-electronic devices because of environment friendly materials with violet-blue and blue emissions. In this term, I focused on maintenance of laser systems and data analysis of transient absorption (TA) spectra of Zn-containing QDs.

1) Maintenance of laser systems for time-resolved spectroscopies.

2) Data analysis of TA spectra of ZnSe/ZnS core/shell QDs.

The TA experiments of ZnSe/ZnS core/shell QDs were performed with 266 nm excitation and detected in UV-visible region. 266 nm pump pulse was the sum frequency of 800 and 400 nm, and UV-visible probe pulse was the super-continuum from a thick BBO crystal with the excitation of 800 nm.
With low excitation intensity, single exciton dynamics of ZnSe core and ZnSe/ZnS core/shell QDs was studied. 1S state filling was observed immediately after 266 nm excitation. Meanwhile, a wide photo-induced absorption band was observed on the red

side of 1S state filling, which is assigned to trapped electrons. With increasing excitation intensities, Auger recombination process was observed. However, in the present samples, the lifetimes of Auger recombination process of ZnSe core and ZnSe/ZnS core/shell QDs are very similar. Quantum yields of both QDs are similar. The ZnS passivation might be not completed. The synthesis method should be revised to obtain a good shell passivation of the core/shell QDs.

3) Data analysis of TA spectra of InP/ZnS alloy QDs.

The TA experiments of InP/ZnS alloy QDs were performed with 400 and 485 nm excitation. With low excitation intensity, single exciton dynamics was studied. Excited electrons relaxed from 1P state to the lowest excited state within 300 fs after 400 nm excitation. A following ~10 ps relaxation process is still in consideration, which might be assigned to electron trapping or relaxation of hot hole. After that, a 3.0 ns relaxation of the excited electron is in good agreement with the photoluminescence result. With increasing excitation intensities, Auger recombination process was observed. The lifetime of Auger recombination process will be discussed in terms of particle size and energy band structure of the alloy QDs.

4) Submission of the manuscript of ultrafast dynamics of Au nanopolyhedrons.

Coherent acoustic phonon vibrations of Au nanopolyhedrons including nanocubes, nanoctahedrons, and nanocuboctahedrons in aqueous solutions and poly(vinyl alcohol) films are investigated using a transient absorption spectroscopy combined with a finite element analysis based on continuum elastic theory. In each kind of nanopolyhedrons, two vibrational modes were observed and induced by the same mechanism, thermal expansion, owing to similar quality factors and phases in both modes. The low-frequency vibrational mode conducts a tip-to-tip displacement in each nanopolyhedron. In contrast, the high-frequency mode is the breathing vibration of the whole particle and represents a morphology dependence, which shows a face-to-face displacement in nanocuboctahedrons, an edge-to-edge displacement in nanoctahedrons, and combination displacements of face-to-face and edge-to-edge in nanocubes. Moreover, a clear phonon beat can be identified upon the two vibrational modes of nanocuboctahedrons. Our experimental results provide a possible application of morphology-controllable metal nanoresonators.

Publications:

1) L. Wang, Shohei Takeda, Ryota Sato, Masanori Sakamoto, Toshiharu Teranishi, Naoto Tamai, “Morphology-Dependent Coherent Acoustic Phonon Vibrations and Phonon Beat of Au Nanopolyhedrons”, ACS Omega **6**, 5485-5489 (2021)

Deadline : Within two months after finishing the research period.

Sabbatical leave with grant: Submit this report to President with confirmation by the dean of school you belong to.

※Postdoctoral fellow is required to submit this report with confirmation by the dean of graduate school before the end of employment period.

Where to submit : Organization for Research and Development and Outreach (NUC)

◆We put this report on the web of KGU. If there is any problem about it because of difficulties on your research, please let us know.