

Nihon University N. Research Project — Summary

Here we are in the final year of our project "Nanomaterial-based Photonic and Quantum and Bio Technologies", which started in academic year 2009 after one year of feasibility research in 2008. The purposes we set up were to address three of the most pressing problems facing the society today -- (i) the information explosion, (ii) the exhaustion of fossil fuels and the related steep increase of atmospheric CO₂ concentration, and (iii) cancer that accounts for a third of Japanese death. They are apparently wide ranging, but if we look into the origin of these problems from a technological point of view, we find that every problem has its roots in materials in the nanoscale. We have focused on the sciences on quantum mechanical interaction between nanomaterials and light and on advanced technologies that rely on them and conducted this collaborative project comprising researchers from five Colleges of Nihon University, each with a background in science, technology, medicine, or pharmacy.

We have achieved many, if not all, of the research goals we initially set up. In the magnetic recording, we have not only demonstrated a possibility of ultrafast recording, but also found a new mechanism of recording. For recording density, we have achieved smaller recording spots than our planned goal. For quantum information technology, we have achieved the original goals about the single photon detector and the entangled photon source and successfully demonstrated their performance. In the energy technology area, we have found new materials that satisfy the requirements for use in fuel cells, while improvement of solar cell efficiency is still on the way. For the PI polyamides, while studies at the cells and mice levels are continued for cancer treatment, a great progress has been made as a drug candidate for the inhibition of skin scar, which was made into ointment and was found effective on mammalian marmoset.

These achievements have been published in many journals including *Nature* and its sister journals such as *Nature Photonics*, *Nature Communications*, and *Nature Materials* as well as *J. Am. Chem. Soc.* etc. and led to 31 patent applications.

A number of new collaborative researches across the Colleges have begun, more than we originally planned, as a result of the project activities. For example, a sintering protocol used by Hashimoto of the College of Humanities and Sciences was applied by Iwata of the College of Science and Technology to the production of high-quality, nano structure-controlled films. A new collaboration has begun between Asai of the College of Science and Technology and Fukuda of the School of Medicine, in which plasma is applied to medicine.

We have placed emphasis on the training and development of young, next-generation researchers through the advanced research. We have provided financial support to (post-doctoral) research fellows and research assistants. Thirty five awards were granted related to the project member, many of which were poster awards and presentation awards to young researchers.

This project has led to a successful selection of a new MEXT strategic project for private universities "Search and Creation of New Materials, Properties, and Devices through Understanding and Control of Ultrafast Interaction between Light and Matter", which we hope will be a successor locomotive for further research activities.

We wish to express our respect and gratitude to professors of the Strategic Research Council for Academic Research and the staff of the Research Promotion Department for the planning, implementation, and support to the "Nihon University Strategic Project for Academic Research" aka "Nihon University *N.* Research Project." We acknowledge the advisory board members for their evaluation and encouragement. We also wish to appreciate all members of Nihon University who allow us to engage in this large-scale project over the last five years.

Here we present the final report, hoping that the achievements of this project will contribute to bring the low-carbon healthy society into reality in the healthy future.

February 5, 2014, Project Leader Prof. Joe Otsuki