「マイクロ固体フォトンクス」特集号によせて

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Preface to Special Issue on Micro Solid-State Photonics

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It is a pleasure for me to have the opportunity to write some introductory comments for the special issue of the Review of Solid State Engineering on the topic of “Micro Solid-State Photonics”, edited by a working group of THE LASER SOCIETY OF JAPAN. Development of solid-state sources of coherent radiation, including lasers and nonlinear optical frequency convertors, has long been a materials-limited field. Advances in device performance like increased optical powers, extended wavelength ranges, and longer lifetimes are in general preceded by improvements in the materials on which the devices are based. Because bringing a new material to adequate quality for use in practical devices, and characterizing its properties in adequate detail, are often decade-long and quite expensive processes, materials that can be systematically engineered to address a broad range of applications are particularly valuable. Two such materials systems, microstructured ferroelectrics for quasi-phases-matched nonlinear optics, and transparent laser ceramics with controlled micro-domain structure, have emerged over the past decade as the basis for a field Prof. Taira describes as Micro Solid-State Photonics. In both systems, the ability to manipulate a given material on a scale of the optical wavelength enables engineering a large range of macroscopic behaviors. These materials systems become a “platform” for a variety of compact and efficient devices addressing a wide variety of applications.

The conference organized in Nagoya and the special issue of this journal edited by the working group of THE LASER SOCIETY OF JAPAN provide an excellent snapshot of the state of Micro Solid-State Photonics, covering developments in materials, devices, and applications of both microstructured

ferroelectrics and laser ceramics. The larger number of papers on periodically poled ferroelectrics reflects their longer history; the use of these materials has increased dramatically in recent years building on a decade of earlier work developing techniques to control the material systems. We see reports ranging from the commercial implementation of one of the ideas that drove the early development of QPM media two decades ago, light sources for projection displays, to devices for quantum teleportation research, a cutting-edge topic in basic science. Across this application spectrum, the successful device implementations result from the progress in developing materials resistant to damage under the high optical intensities involved, and in techniques to pattern their domain structure with adequate precision, topics also addressed in this special issue.

In the area of transparent ceramics, reports describe the rapidly moving developments in controlling microstructure to reduce loss and extend operation to additional host-ion combinations, and the concomitant improvement in the output power, efficiency, and wavelength range of devices based on these materials. It is particularly gratifying to see here reported these two material technologies, microstructured ferroelectrics and laser ceramics, combined synergistically in a single device to generate UV radiation.

The richness of the opportunities afforded by Micro Solid-State Photonics for devices addressing a variety of important applications in science and engineering suggest many years of fruitful research ahead for this field. I thank Prof. Taira of the Institute for Molecular Science for his efforts in assembling this useful current survey of the field.