Overview

Kenji Taniguchi
Guest Editor of the Feature Article Section

We are very pleased to present the feature articles on energy harvesting technologies.

Until recently, the net capture of environmental energy, in the form of mechanical vibration, light, thermal gradient, fluid and wind energies, was so small that it was impossible to convert the energy to perform any useful work. This scenario is about to change. Advanced technical developments have increased the efficiency of devices in capturing trace amounts of energy from the environment and transforming them into electricity in a useful form. In addition, IoT (Internet of things) devices have increased power efficiency and have effectively reduced power consumption. These developments have created interest in the engineering community to develop self-powered IoT sensors at the point of operation. The goal is to eliminate batteries and the attendant need to periodically replace them with the expense of high maintenance costs. However, the main challenges to realize self-powered IoT sensors are to increase output power and energy conversion efficiency of energy harvesters. Thus, it is important to deepen the fundamental understanding of high energy conversion materials and technological solutions for highly efficient structural design.

This issue features the latest developments in energy harvesting technology, with four articles on magnetostrictive, piezoelectric, triboelectric, and photovoltaic harvesting technologies. The articles are the research outcomes conducted under the research fund of the Japan Science and Technology Agency (JST). In the first article, Prof. Ueno describes the development of a magnetostrictive vibration-based power generator to extract mW power semi-permanently from minute vibration. Vibration-exciting mechanisms from movement, wave, and flow, will be developed for wide use in the battery-free IoT. In the following article, Prof. Ohno writes about flexible power generators that harvest electric power from the flow of electrolyte solutions using atomically thin conductive films. The free-shaped power generation devices are able to be installed in various environments where there are fluids containing electrolytes, such as oceans and chemical reactors. Prof. Yamada's article summarizes how he developed films with piezoelectric response by manipulating the polarization in ferroelectric materials in such a way as to maximize the piezoelectric response, and how he fabricated highly efficient nanogenerators. In the final article, Dr. Nakamura describes how materials with broken inversion symmetry exhibit photocurrent generation by light irradiation, i.e., the bulk photovoltaic effect. The origin of the bulk photovoltaic effect is the shift current related to the quantum-mechanical phase of electrons. In his article, he reveals the guiding principle for enhancing the bulk photovoltaic effect and writes on his development of new materials for high-efficiency photon-to-electron conversion.

We would like to express our sincere appreciation to all the authors and editorial members for their valuable time and effort, and to Professor Uritani for his dedicated work on this issue of the *Bulletin*.

We hope that the readers of the *Bulletin* will enjoy this issue's feature articles on state-of-the-art energy harvesting technologies.

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