Special Feature: Materials Analysis Using Quantum Beams

Overview

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The diversification of automobiles into areas such as hybrid and fuel-cell-powered vehicles has led to an increased demand for new materials such as Li-based compounds for the cathodes of Li ion batteries, cathode catalysts for fuel cells, and compound semiconductors for power devices. Such materials must exhibit high reliability and must maintain their properties for the lifetime of the automobile. It is expected that achieving these goals will be greatly aided by the remarkable advances that have been made in materials analysis methods. In particular, large national experimental facilities such as SPring-8 and J-PARC, in addition to overseas facilities, have been constructed and are available for industrial use. These facilities provide new materials analysis techniques using quantum beams such as synchrotron radiation, neutron and muon beams. We first started to use such facilities more than 15 years ago, and found that they made it possible to observe the state of materials under their normal operating conditions, and to directly observe the motion of atoms and ions in solids, which cannot be achieved using conventional laboratory equipment. Facilities such as the Toyota beamline, constructed at SPring-8 in 2008, have now become indispensable in the development of advanced new materials with properties that exceed those of any existing materials.

This special issue includes five technical papers describing recent observations using quantum beams in large facilities. The first introduces two characteristic functions of the Toyota beamline, and the second describes a typical application at the Toyota beamline, which is the development of automotive exhaust catalysts using operando analysis. The third paper reports a new method for analyzing the band structure of semiconductor materials. The final two papers are concerned with the direct observation of atomic and ionic diffusion using advanced muon and neutron based methods. These reports provide excellent examples of the groundbreaking research that is being carried out, and will be continued in the future.