MATERIALS SCIENCE :

"Taranoki" - Japanese angelica tree

Spectroscopic measurement and diffraction are key techniques for investigating the properties of various kinds of materials. Materials Science focusing on electronic and magnetic properties continues to play one of the major roles at SPring-8. This chapter is organized into four parts in terms of the methods: (1) the dynamical properties of materials studied by inelastic X-ray scattering and nuclear forward scattering, (2) studies of electronic structures using Compton scattering, angle-resolved photoelectron spectroscopy (ARPES), and infrared reflectivity methods, (3) the charge density distributions of materials obtained using diffraction methods, and (4) studies on magnetism by soft X-ray magnetic circular dichroism (MCD) and magneto absorption spectroscopy under a high magnetic field. From the materials point of view, on the other hand, this chapter contains the topics of superconductivities, strongly correlated and heavy electron systems, materials with a lack of translational invariance, and magnetic and electric materials geared towards device applications.

ELECTRONIC & MAGNETIC PROPERTIES

Inelastic X-ray scattering and spectroscopic experiments at SPring-8, in common with other third-generation synchrotron facilities, have become powerful tools for investigating momentum- and energy-dependent charge and lattice dynamics, and electronic structures. In the last SPring-8 Research Frontiers, inelastic X-ray scattering studies mostly focused on superconductivities. This issue, however, highlights not only superconductivity, but also the study of lattice dynamics on nanoscale inhomogeneity materials and quasicrystals in order to investigate how lattice dynamics are affected by local order and long-range order, and by nanoscale inhomogeneities. Diamond and β-ZrNCl are both band insulators. However, they show superconductivity when carriers are doped. The effect of phonons on superconductivity is always helpful for understanding its mechanism. In this chapter, we report the investigation of the longitudinal optical phonon dispersion of the highest phonon branch in both non-superconductor and superconductor diamonds by inelastic X-ray scattering, and the isotope effect on superconductivity in Li_xZrNCl to clarify how the electron-phonon interaction is important for superconductivity. In general, boron-doped diamond is categorized as a *p*-type semiconductor with a wide band gap. (LaO)CuS is also known to be a transparent *p*-type semiconductor with a wide band gap of 3.1 eV. Since it is essential to know the direct electron density distributions in the host material (LaO)CuS to understand its unique electrical and optical properties, a work was conducted to analyze the charge density distribution using powder diffraction. Another material that is geared towards device applications is FePt thin film, which shows perpendicular magnetization. The MCD measurement on this system was performed in order to determine the relationship between the thickness and the perpendicular magnetization.

Since SPring-8 has a Compton dedicated beamline, this kind of experimental activity is quite high. In this issue we present a study on ice I_h by a Compton scattering experiment to observe temperature-induced changes in the ground-state electron momentum density.

The *f*-electron system, such as that of lanthanide and actinide compounds, shows fruitful magnetic and electronic properties probably due to the itinerant and localized behavior of *f*-electrons. Therefore, one of the central issues regarding this system is whether 4*f* and 5*f* electrons are itinerant or localized and how this affects the magnetic and electric properties of various compounds. In this chapter we show some interesting results related to this issue for various *f*-electron materials obtained by ARPES, infrared reflectivity measurement, nuclear forward scattering, and magneto-absorption spectroscopy under a high magnetic field.

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