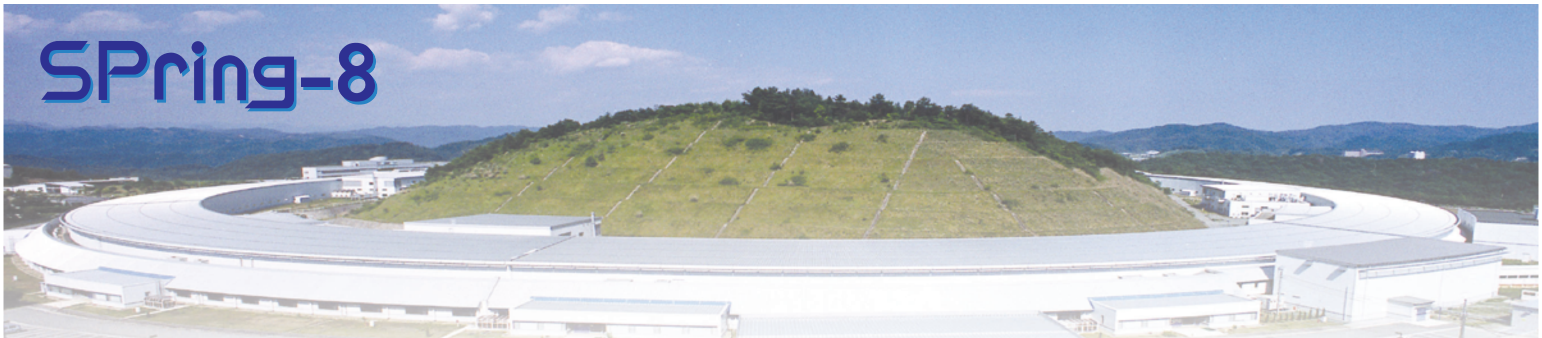

Hard X-ray Nanospectroscopy Station at SPring-8 to Shed Light on Nanochemistry and Nanomagnetism

SPring-8 has recently launched a new experimental station for hard X-ray nanospectroscopy at BL39XU [1–3]. The setup of the new station includes the Kirkpatrick and Baez (KB) mirrors for focusing an X-ray beam down to 50 nm. The dedicated experimental hutch was built 74 m from the undulator source for the installation of the KB mirror optics and relevant instruments at a stabilized temperature and under reduced vibration conditions. The available X-ray energy is in the range from 5 to 16 keV, which allows nano-XAFS study at the K edges of 3d transition metals, and the L edges of the rare-earth elements and 5d noble metals. This hard X-ray nanoprobe can provide bulk-sensitive information on the chemical/magnetic states of the sample. Variable experimental environments will be feasible since no ultrahigh vacuum is required in our setup using hard X-rays. XAFS imaging of the chemical state in working catalysts and environmental specimens are possible key applications. Ishiguro et al. have recently demonstrated the visualization of the chemical states in single catalyst particles [4].

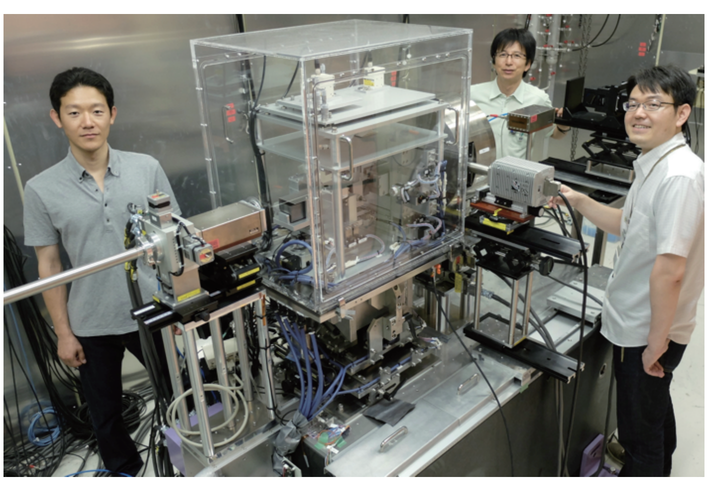

Fig. 1: Left to right; JASRI scientists, Hirokatsu Yumoto, Motohiro Suzuki, and Takahisa Koyama, who commissioned the hard X-ray nanoprobe at SPring-8 BL39XU. The setup includes the KB mirror system in an acrylic chamber, the electromagnet, and the X-ray fluorescence detector.

Other unique features of the nanoprobe are X-ray polarization tunability and fast polarization switching. The newly installed KB mirror optics is combined with an existing diamond X-ray phase plate to produce circularly polarized X-ray nanobeams with a high degree of polarization, enabling hard X-ray magnetic circular dichroism (XMCD) spectroscopy with sub-micrometer resolution. For the study of magnetic samples, a dedicated electromagnet can be used to apply a magnetic field of 22 kOe. With this setup, researchers can perform XMCD measurement in local areas of samples, element-specific magnetometry for patterned magnetic devices as small as 100 nm [1], and scanning XMCD imaging during magnetization processes in a moderate magnetic field. These above-mentioned features are particularly useful for the study of next-generation magnetic recording devices with high magnetic anisotropy as well as sintered permanent magnets with fine-grained structures, which have been applied to high-efficiency motors. Our new nanospectroscopy station can contribute to remarkable progress in nanochemistry and nanomagnetism, paving the way to green innovations for a sustainable society.

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