(Article: 11)

A COMPREHENSIVE FACILITY FOR EXAFS MEASUREMENTS AT INDUS-2 SYNCHROTRON SOURCE AT RRCAT, INDORE, INDIA

Dr Dibyendu Bhattacharyya

Sr. Scientist, Atomic & Molecular Physics Division,
Bhabha Atomic Research Centre, Mumbai-400 085, INDIA
(e-mail: dibyendu@barc.gov.in, dibyendubarc@gmail.com)

ABSTRACT

Extended X-ray Absorption Fine Structure (EXAFS) technique, which deals with the fine structure oscillations observed in the X-ray absorption spectra of an element from 50 eV to ~700 eV above its absorption edge, gives precise information regarding the short range order and local structure around the particular atomic species in the material. With the advent of modern bright Synchrotron radiation sources, EXAFS has emerged to be the most powerful local structure determination technique, which can be applied to any type of material viz. amorphous, polycrystalline, polymers, surfaces and solutions. Over the last few years a comprehensive facility for carrying out EXAFS measurements with synchrotron radiation over a variety of samples has been developed at the 2.5 GeV, Synchrotron Radiation Source (INDUS-2) at RRCAT, Indore, India. The facility consists of two operational beamlines viz., the Energy Dispersive EXAFS beamline (BL-8) and the Energy Scanning EXAFS beamline (BL-9).

ABSTRACT

The Energy Dispersive EXAFS beamline (BL-8) uses a 460 mm long Si (111) single crystal mounted on a mechanical crystal bender which can bend the crystal to the shape of an ellipse. The crystal selects a particular band of energy from white synchrotron radiation depending on the grazing angle of incidence of the synchrotron beam (Bragg angle) and disperses as well as focuses the band on the sample. An Rh coated cylindrical pre-mirror with meridional curvature is used for rejection of higher harmonics and vertical focusing of the beam. The radiation transmitted through the sample is detected by a position sensitive CCD detector having 2048 x 2048 pixels. The whole absorption spectrum of the sample can be recorded simultaneously on the detector within fraction of a second.

The beamline operates in the energy range of 5-20 keVwith a resolution of 1 eV at the photon energy of 10 keV. The absorption spectrum of a sample as a function of incident photon energy is obtained by recording the intensities on the CCD, without and with the sample. The beamline is particularly useful for in-situ and time-resolved studies on samples in transmission geometry.

The Energy Scanning EXAFS beamline (BL-9), on the other hand, has been developed to facilitate EXAFS measurements on samples both in transmission and fluorescence modes within the energy range of 4-25 keV. The beamline optics consists of a Rh-Pt coated cylindrical collimating mirror, a Double Crystal Monochromator (DCM) with sagitally bent 2^{nd} crystal for horizontal focussing and a cylindrical post mirror for vertical focussing of the beam.

ABSTRACT

For measurements in transmission mode, three gas-filled ionization chambers are used, while for measurements in fluorescence mode an ionsation chamber based Lytle detector or a Si-drift detector is used in front of the sample. The beanmline is particularly useful for dilute samples and samples deposited on thick substrates. The above two beamlines are complementary to each other and are being regularly used by researchers from different research laboratories and universities for characterization of various types of samples of current technological importance. The beamlines also provide in-situ measurement facility over a wide temperature range from 10 K to 1000K and also under various gaseous environments.

The present talk will cover the basic principle of EXAFS technique, basics of beamline instrumentation required to carry out EXAFS measurements with synchrotron radiation, the method of data acquisition in various modes, data analysis procedure and finally examples of EXAFS measurements on a few of technologically important samples using the above beamlines.