Beamlines for XAS spectroscopy at Synchrotron Light Research Institute in Thailand

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Abstract

X-ray absorption spectroscopy (XAS) has proven to be the most popular technique at Synchrotron Light Research Institute (SLRI) in Thailand, thereby resulting in the largest number of users' publications, 230 papers in peer-reviewed journals, during the past two years. There are currently four XAS beamlines (BL1.1, BL2.2, BL5, and BL8) serve SLRI's users, who can submit experimental proposals via an online, SLRI's beamtime application system (http://beamapp.slri.or.th). Utilizing synchrotron radiation emanating from a bending magnet (1.44 T) of the 1.2 GeV Siam Photon Source (SPS), BL2.2, BL5, and BL8 perform XAS experiments in soft-tender X-ray energy ranges of 4-12 keV, 1.25-13 keV, 1.25-10 keV, respectively. These energy ranges cover elements in the third and fourth row of the periodic table, i.e. magnesium to selenium. Higher X-ray energies (4-18 keV) are available at BL1.1 utilizing synchrotron radiation from a multipole wiggler (2.2 T); therefore, heavier elements such as gold, mercury, and lead can be studied at this beamline. In this presentation the SPS's radiative characteristics and beamlines' instruments will be described. Suitable experimental setups for a variety of samples measured in transmission, fluorescence-yield, and electron yield modes will be presented together with resultant X-ray absorption near edge structure (XANES) spectra and extended X-ray absorption fine structure (EXAFS) spectra. Methods for analyzing XANES and EXAFS data will be demonstrated: determination of oxidation states and speciation with combined XANES chemical fingerprints of experimental standards, extraction of structural parameters at the atomic level (interatomic distances, coordination numbers, and types of neighboring atoms) by EXAFS fitting, and XANES spectral calculation based on a representative atomic model.

Wantana Klysubun is scientist of Research Facility Division at Synchrotron Light Research Institute (SLRI) in Thailand.

She obtained her Ph.D in 2001 on a thesis about optical studies of highly doped GaAs: C using experimental infrared reflection and absorption spectroscopy and Raman Scattering. She had a career training at the world-largest synchrotron facility, SPring-8 in Japan, and gain hand-on experience about beamline optics, instrumentation and engineering works. During 2006-2013, she was in charge of the designs, installation, and commission of X-rays beamlines at SLRI: BL5.2, BL7.2, and BL8. She has been the Manager of the beamline BL8, which is internationally recognized as one of the best beamline for studying X-ray Absorption Spectroscopy (XAS) of low elements such as phosphorous and sulfur. The success of BL8 significantly increases the number of synchrotron XAS users and demands for more XAS facilities at SLRI. For the last three years, BL8 have conducted 199 experimental users' projects yielding 114 publications. Her pioneer work of XAS beamline development resulted in receiving the L'Oréal-UNESCO Followship Award for Women in Science in 2010. As a chairperson, she has organized ASEAN Workshops on XAS and Users' Training at SLRI, giving talks to participants.

During 2011-2017, She has explored XAS to characterize archeological and historical glass, particularly the ancient decorative mirrored glass, aka Kriab mirror. Working with her research team, A method of making Kriab mirror's replicas, namely SynGlass, has been invented and applied for Thailand Patent, along with the unique glass formulas to reproduce the faithful colors of the historical glass. The research is currently driven by public needs of SynGlass to restore historical artifacts.

Since 2016, she established Synchrotron Center for Cultural Heritage Materials at SLRI to expand synchrotron radiation applications in the field on many classes of Thailand's historical relics. The ongoing investigations comprises ancient bronze fragments and unidentified beads with the Thailand's Fine Art Department and hidden historical paints with the Foundation of Mrigadayavan Palace.

She is (co)author of 66 scientific papers dealing with non-destructive, XAS analysis in the areas of cultural heritage, materials science, and environmental science.