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High Energy Resolution X-ray Spectroscopy at SSRL and LCLS: Instruments and Applications

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High-resolution hard x-ray spectroscopies (XES, HERFD, RIXS, XRS) are now well-established characterization tools for providing insights of material's electronic and geometric structure. The high brilliance synchrotron radiation beamlines have made feasible the routine study of the electronic structure and ligand environment of metal coordination compounds and active centers in metalloproteins, electrochemical process under in-situ conditions, as well as studies on catalytic systems under ambient conditions. Moreover, the recent availability of Linac Coherent Light Source (LCLS), provides some unique opportunities for the study of ultrafast electronic structure dynamics in various phenomena such as electron transfer processes, transient molecular states, molecular dissociation, etc. At SLAC National Accelerator Laboratory we have developed recently a set of high-resolution x-ray spectroscopic capabilities based on various multichannel spectrometers. At SSRL we have built three multichannel Johann spectrometers enabling XES/RIXS/HERFD techniques as well as X-ray Raman Spectroscopy. For LCLS, we have developed an energy dispersive multichannel von Hamos spectrometer that records simultaneously the overall emission spectrum, enabling shot-by-shot time-resolved studies. Representative examples of application will be shown and discussed from the ongoing spectroscopy programs of SSRL and LCLS.

[1] D. Sokaras et al, *Rev. Sci. Instrum.* 83, 043112 (2012); D. Sokaras et al, *Rev. Sci. Instrum.* 84, 053102 (2013), [2] R. Alonso-Mori et al, *Rev. Sci. Instrum.* 83, 073114 (2012); R. Alonso-Mori et al, *PNAS* 109, 47, 19103 (2012)

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