

Spectroscopic Synergy at the ASTRA Beamline: Combining X-ray Absorption and Raman Spectroscopy for Advanced Analysis of Complex Materials

L. Alluhaibi^{1*}, A. Maximenko¹, G. Gazdowicz¹, D. Zalka¹, M. Brzyski¹,
M. Piszak¹, H. Lichtenberg², A. Prange² and J. Hormes³

¹Solaris National Synchrotron Radiation Centre, Jagiellonian University, 30-392 Kraków, Poland

²Hochschule Niederrhein University of Applied Sciences, Krefeld, Germany

³Institute of Physics, Rheinische Friedrich-Wilhelms-Universität, Bonn, Germany

*e-mail: lulu.alluhaibi@uj.edu.pl

Combining X-ray Absorption Spectroscopy (XAS) with vibrational techniques like Raman spectroscopy provides a powerful approach for studying structural and chemical changes in materials, particularly catalysts. Simultaneously recording XAS and Raman data enables the observation of structural transformations in solid materials while monitoring adsorbed species on their surfaces, offering a more comprehensive understanding of dynamic processes.

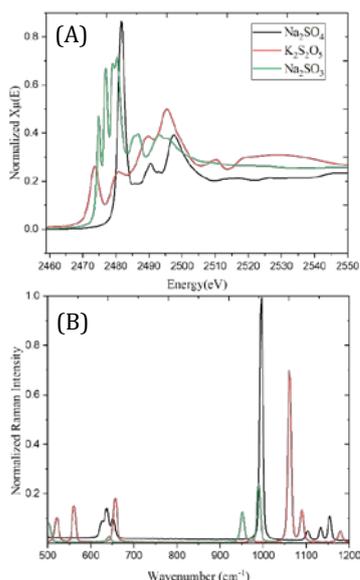


Figure 1. Preliminary results recorded at the ASTRA beamline: (A) S K-edge XANES spectra acquired in transmission mode at room temperature under 30 Torr N₂; (B) Raman spectra collected using a 785 nm laser at room temperature.

Raman spectroscopy is a versatile tool for in situ studies of chemical structures and interactions in gases, liquids, solids, and interfaces. When combined with XAS, it provides detailed correlations between the local electronic structure (XAS) and molecular vibrations and bonding environment (Raman). This integration is particularly valuable for investigating complex materials, where subtle changes in local structure can significantly impact overall properties. While XAS probes oxidation states, coordination geometry, and molecular frameworks, Raman spectroscopy reveals vibrational characteristics, allowing for cross-validation and deeper insights into chemical states and bonding environments.

In July 2024, a Raman spectrometer with two laser sources (782 nm and 532 nm) was successfully installed at the XAS beamline ASTRA (SOLARIS synchrotron). This advancement enables making XAS and Raman measurements at the beamline during one beamtime, providing a unique and powerful tool for comprehensive material analysis. Once fully integrated, this capability will significantly enhance research possibilities, particularly for studying complex materials and processes under real-world conditions in the tender energy range. This presentation will discuss the technical aspects of the beamline, along with selected results from ex situ and in situ experiments.

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