Synchrotron-based Ambient Pressure X-ray Photoelectron Spectroscopy (APXPS) Study of CO Oxidation on Copper

Amin Mohammadpour[1,2], Robert Temperton[3], Andrey Shavorskiy[3], Jonas Weissenrieder[4], Sarp Kaya[1,2]

[1] Department of Chemistry, Koç University, 34450 Istanbul, Turkiye.

[2] Koç University Tüpraş Energy Center (KUTEM), 34450 Istanbul, Turkiye.

[3] MAX IV Laboratory, Lund University, Lund, Sweden.

[4] School of Engineering Sciences, KTH Royal Institute of Technology, Stockholm, Sweden.

Abstract

As part of the HESEB project, I spent time at the HIPPIE beamline in MAX IV Laboratory to gain expertise in utilizing synchrotron-based soft X-ray techniques for conducting experiments. Ambient pressure X-ray photoelectron spectroscopy (APXPS) is a surface-sensitive technique employed to analyze elemental composition, as well as the chemical and electronic states of atoms on surfaces at elevated pressures. Employing a synchrotron radiation source for APXPS measurements enables us to carry out operando experiments with higher energy resolution and sensitivity. This method facilitates the investigation of dynamic processes occurring on a sample's surface under more realistic conditions. One of the reactions which is interesting to study with operando measurements is CO oxidation. Different surface terminations of Cu can exhibit varying levels of activity and selectivity. In our study at HIPPIE beamline, our objective was to explore CO oxidation on Cu(211) and Cu(111) single crystal surfaces with combination of time resolved APXPS and Infrared Reflection Absorption Spectroscopy (IRRAS) measurements. We found that various Cu surface terminations lead to the formation of different surface intermediates. Specifically, the formation of carbonyl and carbonate was observed to differ between the Cu(211) stepped surface and Cu(111) flat surface.

In our upcoming endeavors at the HESEB beamline in SESAME, we intend to employ synchrotron soft X-ray absorption spectroscopy (XAS) techniques to investigate single atom catalysts supported on carbon-based materials. This method will enable us to explore the electronic structure of single atoms, such as Cobalt (Co) and Iron (Fe) supported on graphene oxide. Our focus will be on measuring the L-edge characteristics of elements like Co and Fe, as well as the K-edge of Carbon (C), Oxygen (O), and Nitrogen (N). These measurements will provide insights into the bonding nature on the catalyst.