Evolution of active species in ethylene epoxidation over silver foil revealed by ambient pressure X-ray photoelectron spectroscopy

M. guo[1,2], J. A. Bokhoven[1,2]*, L. Artiglia[1]*

[1]Paul Scherrer Institute, CH-5232 Villigen, Switzerland , [2]Institute for Chemical and Bioengineering, ETH Zurich, CH-8093 Zurich, Switzerland

The ethylene epoxidation (EPO) is one of the most important industrial catalytic reactions and silver-based catalysts have outstanding activities and selectivities in this reaction. Silver-based model catalysts (foils, powder, single crystals) have been extensively used to investigate the fundamental steps of EPO. It has been widely proven that surface oxygen species participate in the catalytic cycle and their property is a key factor in the selectivity of EPO. However, the nature of oxygen species and their roles in EPO are still unclear. In the current work, silver foil was characterized systematically as the starting step of a project aiming at chemical looping process of EPO. Ambient pressure X-ray photoelectron spectroscopy was used to investigate the effects of temperature and gas environment under both steady state and transient condition experiments. Three types of oxygen species correlated to different structures of AgO_x were unveiled on Ag foil. All of them proved to be highly sensitive to temperature and ratio of reagent, and participate in the reaction with ethylene. The key role of subsurface oxygen species was revealed over silver foil during the EPO process. Dichloroethane was cofed at a ppm level in the end to investigate the significant effect of chlorine on the selectivity of ethylene oxide

[1] Pu, T. C., et al. *ACS Catalysis*, **2019**, 9, 10727-10750
[2] Jones, T. E., et al. *ACS Catalysis*, **2018**, 8, 3844-3852
[3] Carbonio, E. A., et al. *Chemical Science*, **2018**, 9, 990-998
[4] Rocha, T. C. R., et al. *Journal of Catalysis*, **2014**, 312, 12-16