

Spectroelectrochemical investigations of alcohol oxidation reactions coupling ATR-IR spectroscopy and electrochemistry

The selective oxidation of alcohols is an important reaction in organic synthesis and chemical industry, e.g. in the production of fine chemicals like aldehydes, ketones or acids. A valuable strategy to avoid harmful stoichiometric oxidizing agents such as chromates, permanganates or chlorinated epoxides producing huge amounts of wastewater and by-products [1] is the aerobic oxidation in the liquid phase. In this reaction, O₂ or air is used as the oxidant providing both economic and environmental advantages. An alternative approach for liquid-phase oxidation reactions is the application of an electrical potential established between 2 electrodes. In contrast to thermally driven reactions, electrochemical reactions occur only at the electrode/electrolyte interface. Under potential control, the interfacial region has a distinct structure consisting of ions and solvent molecules that is commonly referred to as the electrochemical double layer. Thus, probing the double layer by an analytical technique is an inevitable requirement to obtain fundamental knowledge about an electrochemical reaction, because the presence of different ions in the double layer can affect the current yields [2].

A suitable technique that allows the investigation of liquid-phase reactions is attenuated total reflection infrared (ATR-IR) spectroscopy. The coupling of ATR-IR spectroscopy and electrochemistry is a challenging task, since the investigation of heterogeneous catalysts is performed in an experimental configuration, in which the electrochemical reaction occurs in a thin electrolyte layer. This module will demonstrate challenges and opportunities of a spectroelectrochemical FTIR set up using a 3-electrode set-up with adjustable distance between the internal reflection element and the working electrode.

[1] M. Haruta, Nature 437 (2005) 1098–1099

[2] D. Strmcnik, K. Kodama et al., 1 (2009), 466-472