RamanFest November 09-10 2023 Paris | FRANCE

Michael Georg Stadt
Silvia Larisegger, Michael Nelhiebel, Günter Fafilek
KAI GmbH, Europastraße 8, 9524 Villach-St.Magdalen/TU Wien, Getreidemarkt 9, 1060 Wien
MichaelGeorg.Stadt@k-ai.at

In-situ Raman Spectroscopy of Defined Oxide Layers in an Electrochemical Solid-State Setup

Copper oxidation processes are critical because their occurrence causes a variety of issues in the subsequent processing and operation of electronic devices and other technical applications. Extensive investigations on thermal oxidation at different temperatures and oxygen partial pressures resulting in various compositions of the oxides were carried out.

In this work, a Raman heating stage is utilized to analyze thin oxide layers during their controllable formation. Controllable oxidation states are achieved in a solid-state electrochemical cell by polarizing a copper sample in contact with a single crystal of yttria-stabilized zirconia (YSZ), which is conductive for oxygen ions at high temperatures. According to the Nernst equation, the oxygen partial pressure at the interface to the metal can be set by applying specific potentials. The optical transparency of the YSZ single crystal allows the Raman laser to pass through the crystal to analyze the copper oxide formed on the copper-electrolyte interface.

Kinetic and thermodynamic information is provided by cyclic voltammograms about the oxidation processes. Thus, the potential corresponding to the oxygen partial pressure controls the various oxidation reactions, whereas the current measures the layer growth rate. In-situ Raman measurements enable more detailed chemical oxide analyses. The combination is used to develop an oxide layer growth model, focusing on the defect chemistry of copper oxide.

Figure

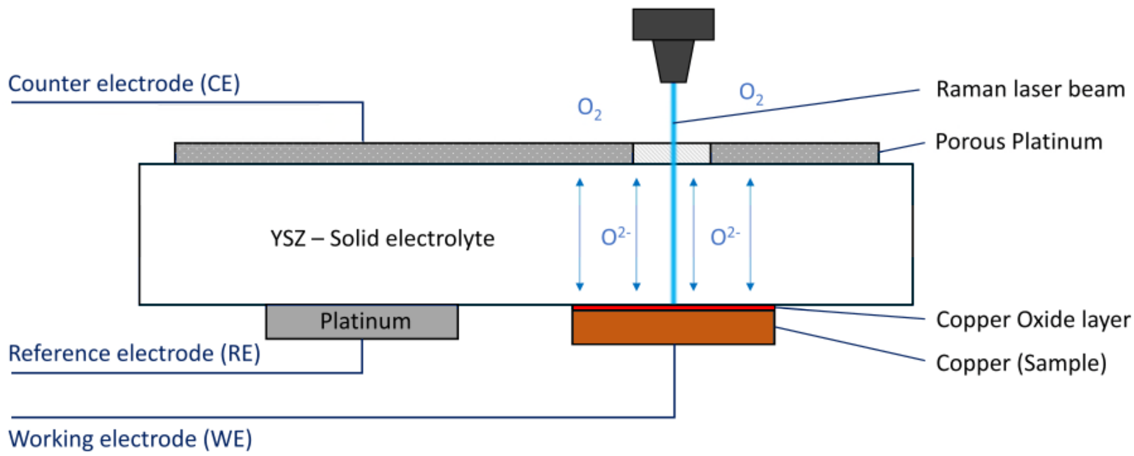

Figure 1: Schematic of the high-temperature setup for in-situ Raman measurement during the electrochemical controlled oxidation.