Masterarbeit

Does the morphological and composition heterogeneity of a new titanium oxycarbide material reflect electrochemical heterogeneity? A scanning electrochemical microscopy study

A new hybrid titanium oxycarbide material has been recently synthesized. This material is prepared by an anodic oxidation of titanium to titanium oxide which in the next step is followed by a reduction in acetylene atmosphere at elevated temperatures. This material conducts electrical current similarly to a glassy carbon electrode. Preparation of new conductive materials is highly required in quickly developing branches of electrochemistry for energy storage and conversion such as new Pt-free catalysts for fuel cells, electrodes for photocatalytic water splitting reaction, and electrodes in photovoltaic devices. Titanium and its derivatives find a broad application in this research field.

XPS studies indicate that the surface of TiO_xC_y is composed of graphite, titanium oxide and titanium oxycarbide with average composition $TiO_{0.6}C_{0.4}$. At the microscopic level, the surface of TiO_xC_y is highly inhomogeneous. TiO_xC_y surface is composed of irregular grains with an average diameter of (16 $\pm$ 7) µm. The surface roughness at different grains varies between 3 and 20 nm.

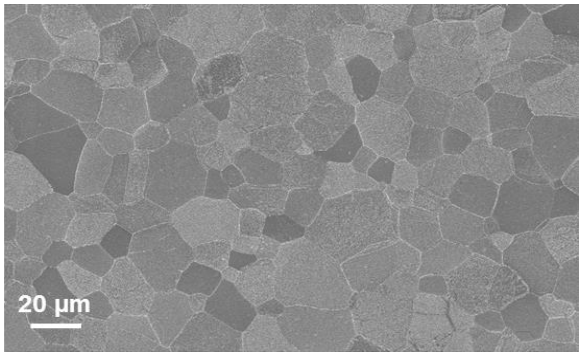

Figure 1. SEM image of a TiO_xC_y substrate produced at 750 °C

It is already known that TiO_xC_y conducts electrical current similarly to the glassy carbon electrode. However, it is not known if the local electrochemical activity of this material is uniform across it entire structure or it reflects the morphological and composition heterogeneity. In this study scanning electrochemical microscopy (SECM) will be used to address this interesting problem. Pt microelectrodes of different sizes (radius 12.5 to 1 nm) will be prepared and their electrochemical performance will be tested in electrolyte solutions containing various mediators such as $[Fe(III)(CN)_6]^{-3}$, methanol ferrocene and $Ru(NH3)^{+3}$. Next, the approach curves in a selected mediator will be measured to different spots at the TiO_xC_y surface. In order to obtain information about the electrochemical activity of the TiO_xC_y substrate SECM imaging will be performed.

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