Study of the decomposition of the polymers in the active layer in PEFC

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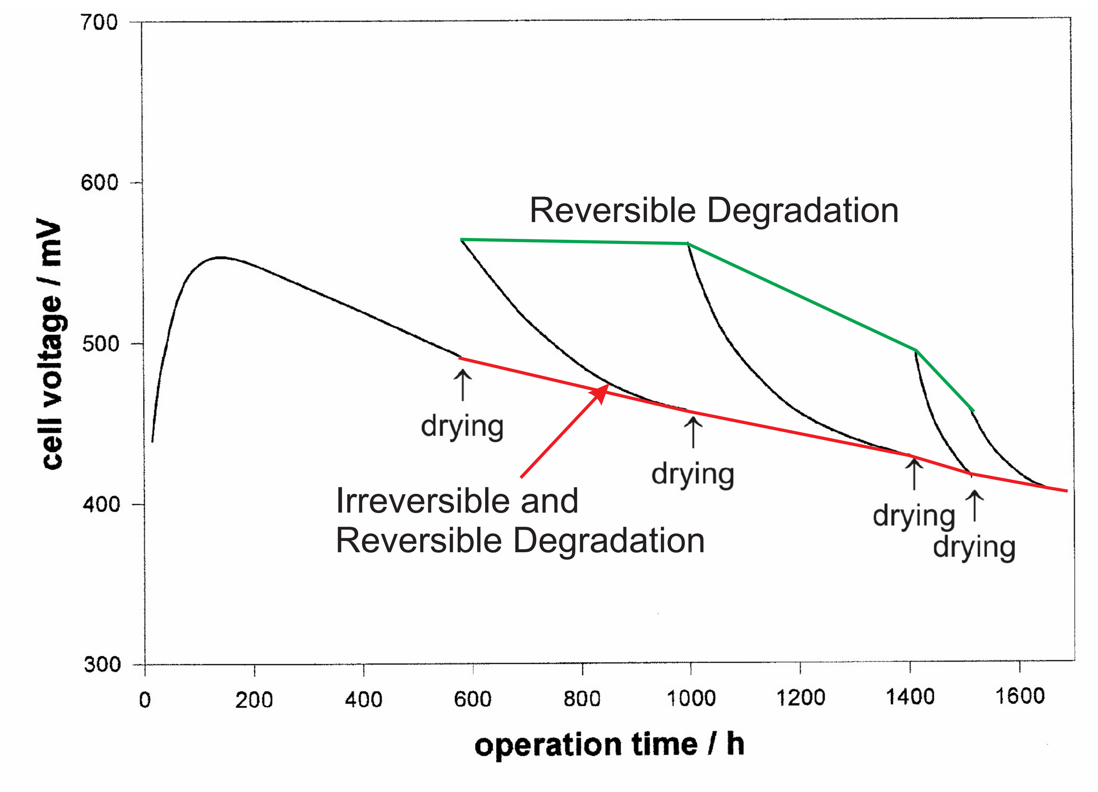
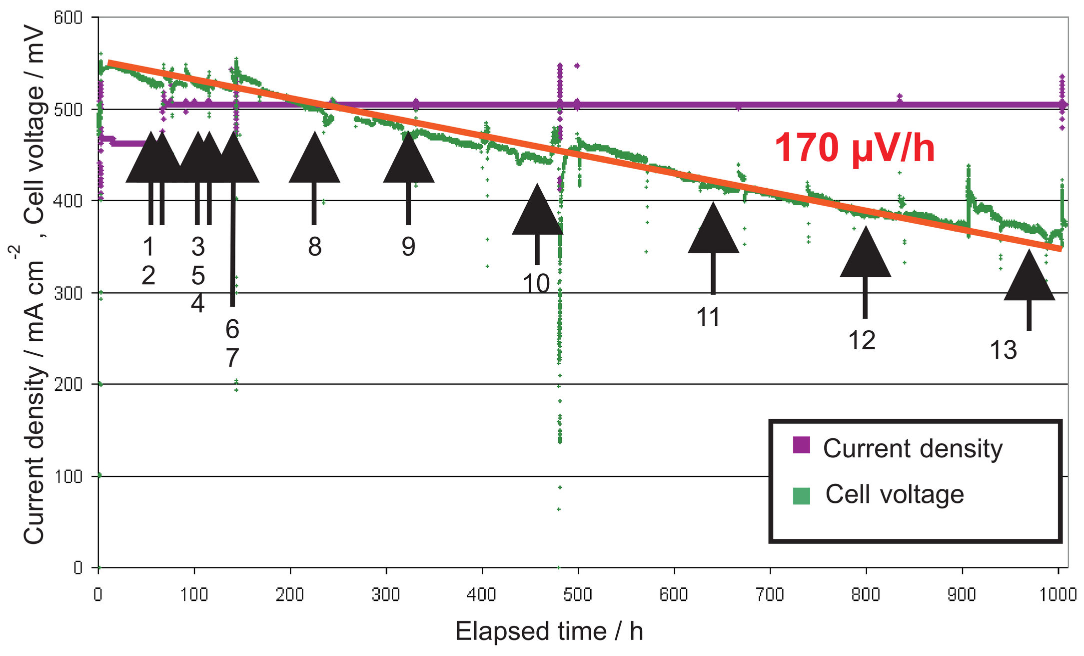
Introduction

The water management in PEFC is one of the most important parameters for the fuel cell performance. In order to optimize the performance of fuel cells which are related to the transport processes the complex structure of the active layer is important which contains catalyst, ionomer particles or films and in some cases hydrophobic agents. For this purpose Nafion with a PTFE backbone and sometimes PTFE itself is used in the active layer, the latter component for hydrophobizing purposes. Due to the fuel cell operation these polymers partially decompose thereby losing their specific function in the active layer. The alteration of the polymers in the active layer was studied by X-ray photoelectron spectroscopy (XPS) and Fourier transformed infrared spectroscopy (FTIR-ATR). With both methods the alteration of the polymers in the active layer could be observed. The XPS-measurements shows that the decomposition of the polymers in the anode layer is more significant than in the cathode layer. A similiar decomposition of the polymers was also observed in earlier studies on alkaline fuel cell electrodes. For this system also the decomposition of the PTFE in the anode was more significant than in the cathode although the environmental in both fuel cell types, PEFC and AFC is strongly different.

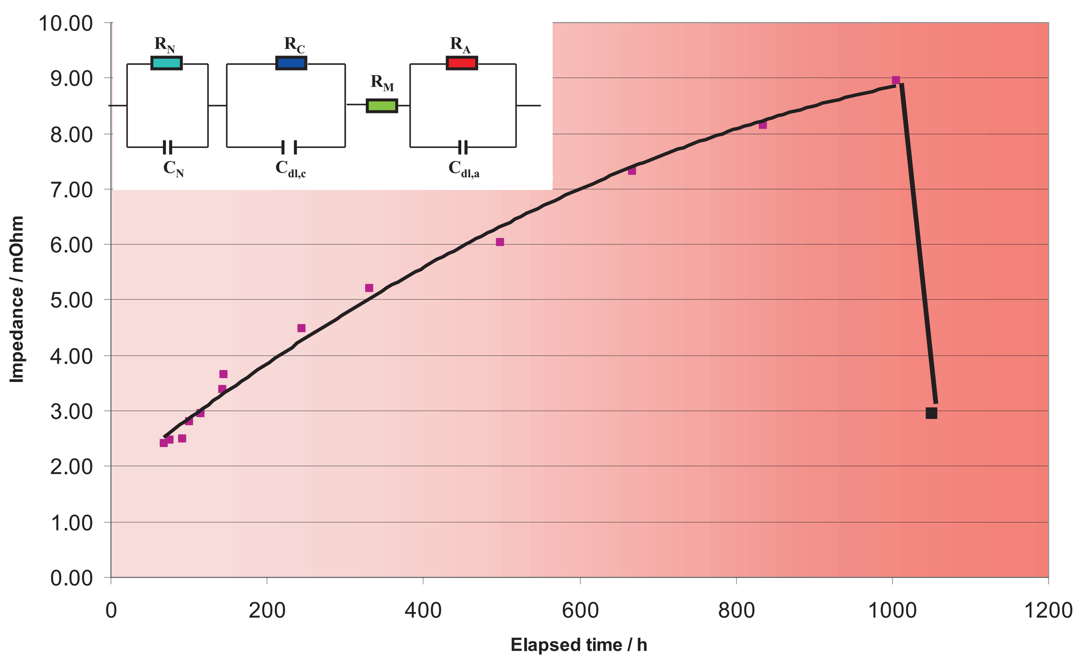
Problems of degradation of hydrophobic components



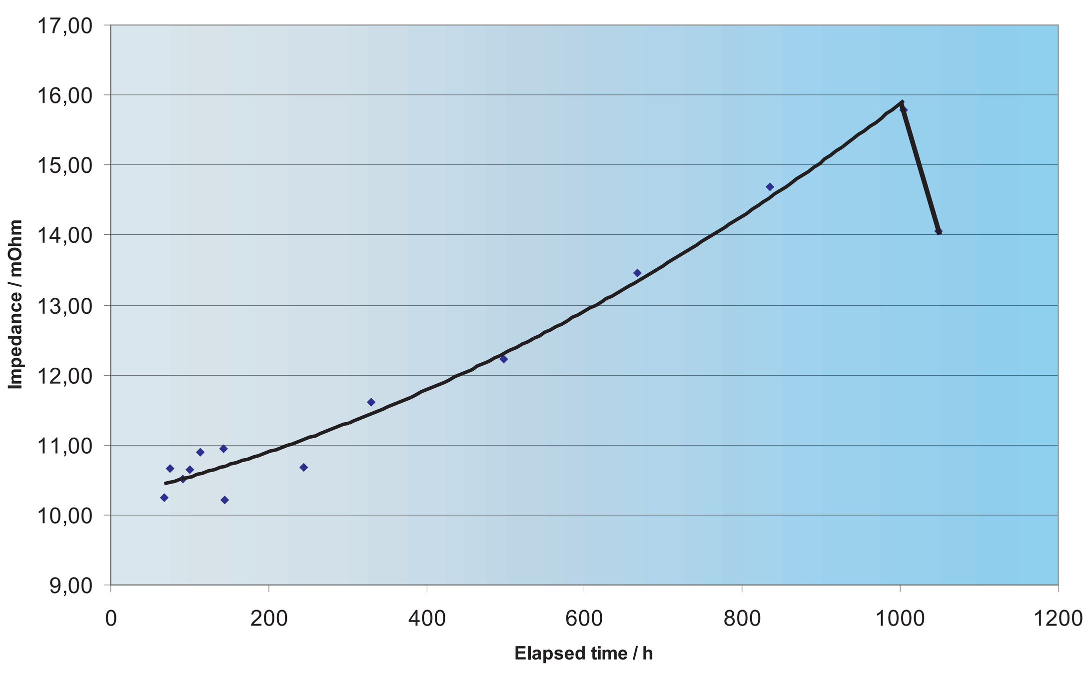
Cell voltage as function of time at constant loading



Change of cell voltage during constant load at 500 mAcm^{-2} operated with H_2/air at 80°C

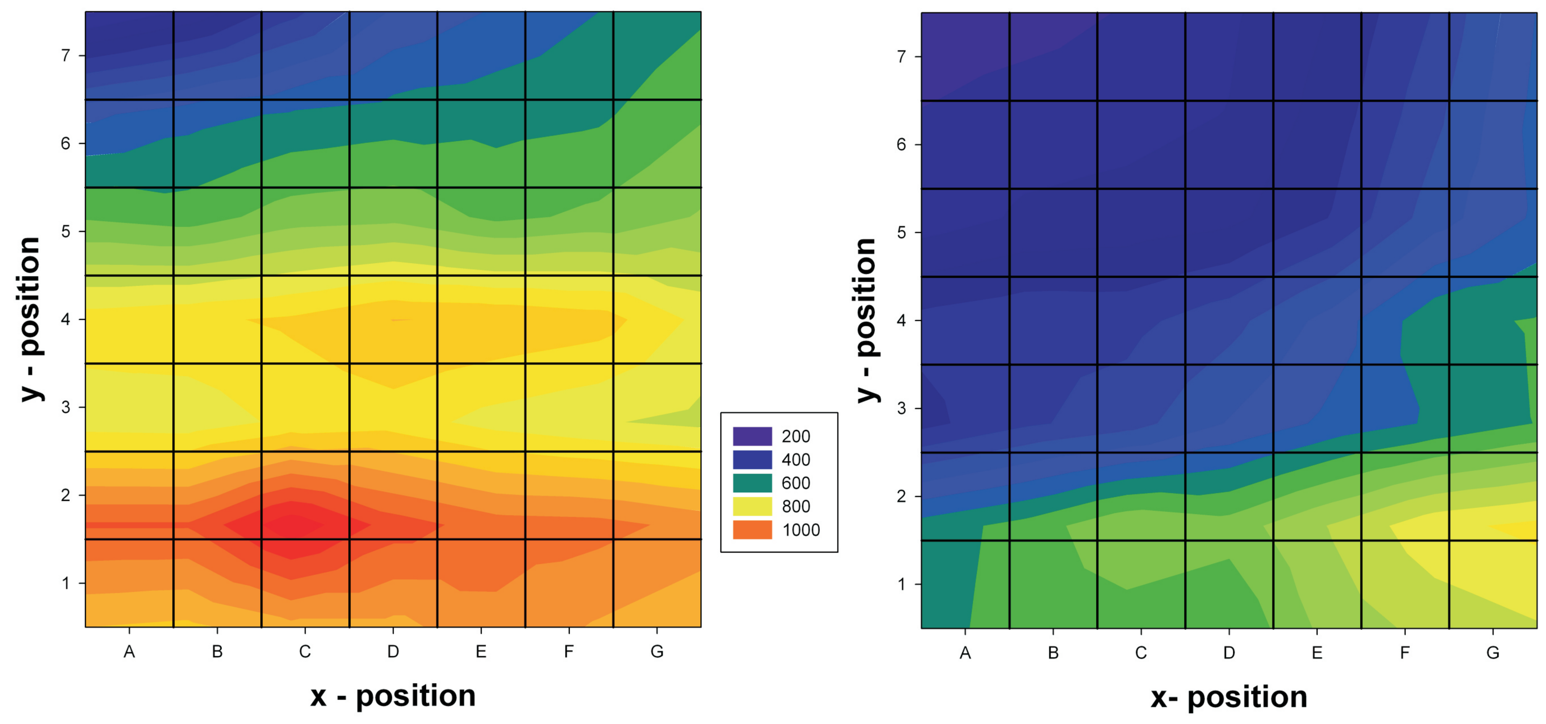


Variation of the transfer resistance related to the anode reaction derived from the impedance measuremen using the equivialent circuit

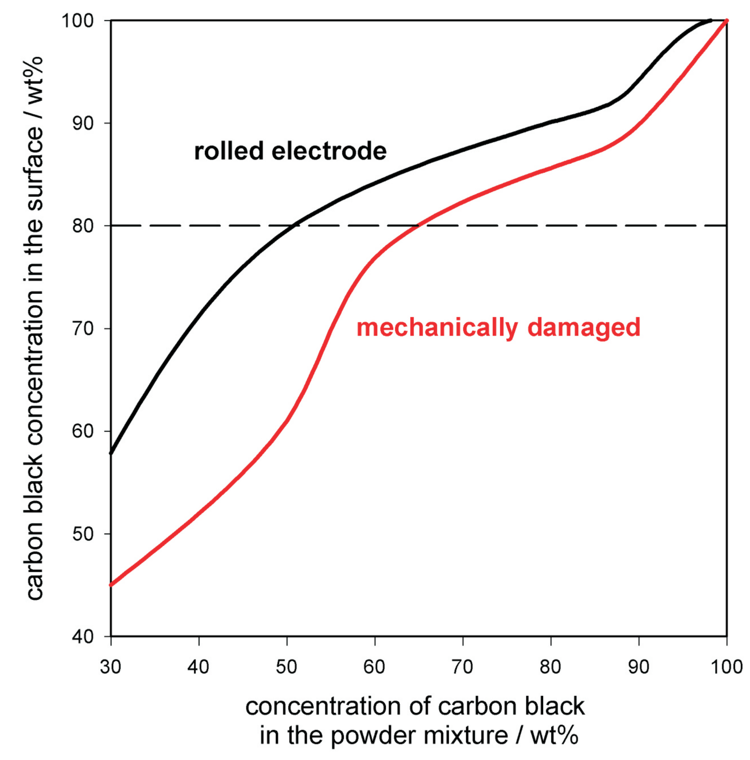


Variation of the transfer resistance related to the cathode reaction derived from the impedance measurement using the equivialent circuit

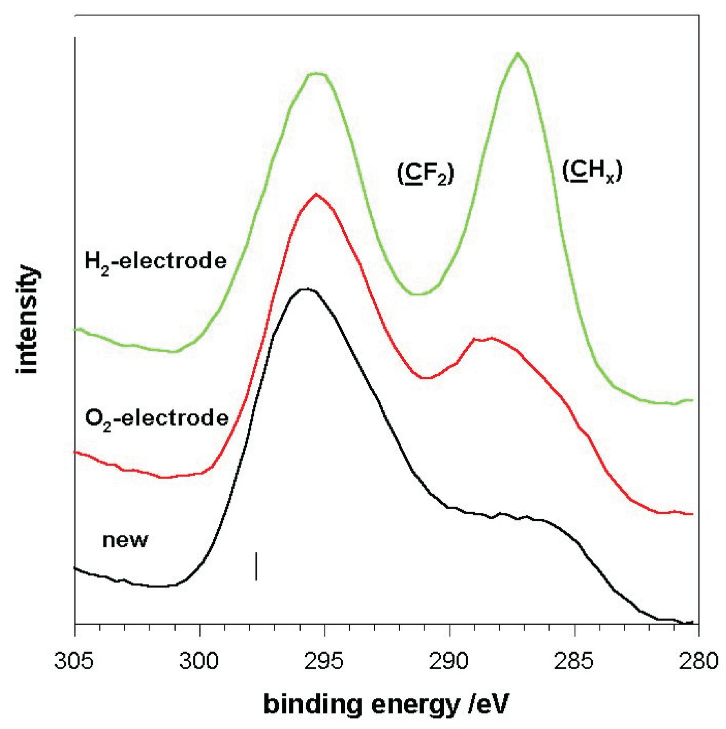
Investigation of degradation



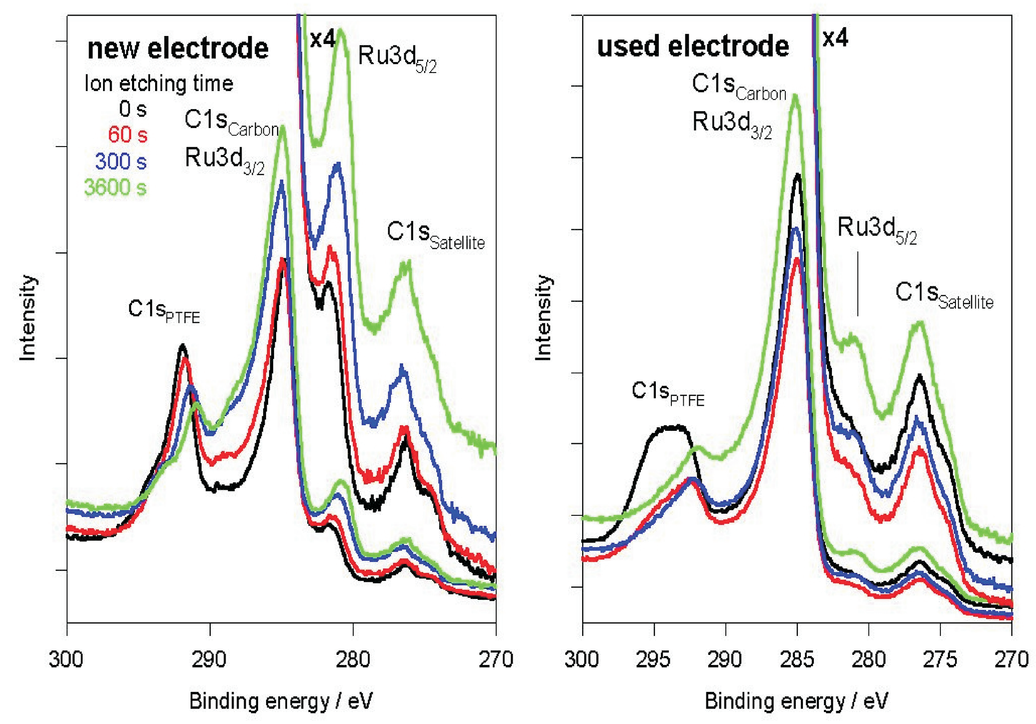
Alteration of the current density distribution due to long term operation at potentiostatic conditions (600 mA/cm2). The alteration of the current density distribution is related to changes of the water management inside the cell (alteration of the hydrophobic properties).



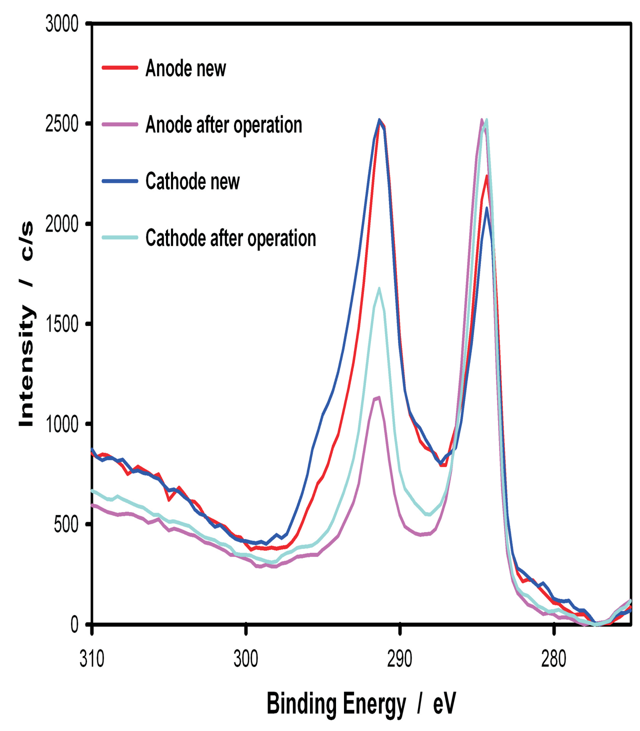
Carbon black concentration in dry prepared electrodes before and after mechanical stressing of the surface



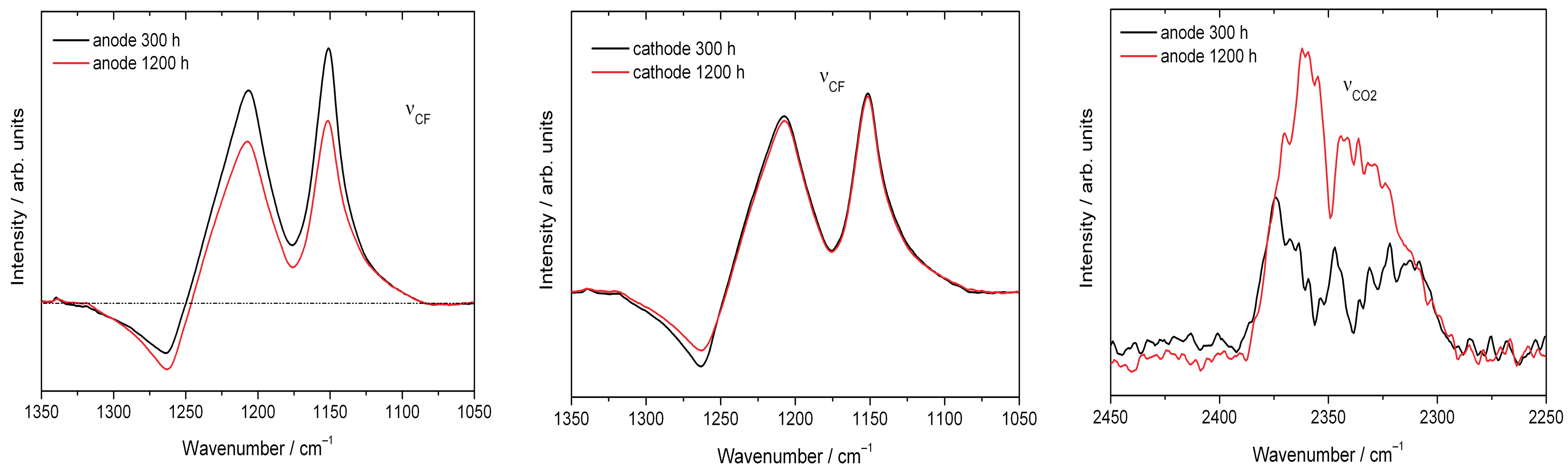
X-ray photoelectron spectra of used and new electrodes (E-Tek);
green: used anode,
red: used cathode,
black: new electrode



C1s spectra of a DMFC anode before and after fuel cell operation



X-ray photoelectron spectra of used and new reaction layers of a CCM (IonPower)



FTIR spectra of PEFC reaction layers after two different periods of operation (black 300 h and red 1200 h).
left side: Spectra of the CF vibration measured on the anode
middle: Spectra of the CF vibration measured on the cathode
right side: Spectra of the CO vibration measured on the anode

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