SUPPORTING INFORMATION

In-Depth Profiling of Degradation Processes in a Fuel Cell: 2D Spectral-Spatial FTIR Spectra of Nafion Membranes

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Experimental Section

The two investigated Nafion MEA's were based on N115 (thickness 125 μm) with dispersed Pt/C electrodes. One MEA was in situ degraded under open circuit voltage (OCV) for 52 h, the other for 180 h. Fuel cell operating conditions were: 90°C, H_2/O_2, 250/250 sccm, 30% relative humidity (RH) of inlet gas streams.

FTIR measurements were performed for all membranes after catalyst removal. The catalyst layers were dislodged in a two step process: Initially the catalyst was wiped off mechanically by gentle grating with Kimberly–Clark wipes; in the second step the pre-cleaned membrane was inserted into a water ultrasonic bath for 10 min. Cleansed membranes were cut with a microtone blade into 1 mm high and 25 mm long stripes. The samples were then placed in a sample holder perpendicularly to the detector. Line scan measurements were performed through the cross-section of the membrane from the cathode to the anode, as shown in Figure S1.

All FTIR spectra were collected with the Perkin-Elmer Spectrum 100 spectrometer coupled with Spotlight 200 high-performance microscopy platform equipped with a single Mercury-Cadmium-Telluride (MCT) detector. FTIR spectra of Nafion MEAs were acquired in the reflectance mode. Line scans were performed with the same aperture settings for all samples, and focusing was performed manually for each sample and kept constant though the entire

scanning process. FTIR spectra were collected with 15 μm steps; the aperture size for each scan step was 20×100 μm. Measurements were performed with 4 cm^{-1} spectral resolution and 512 scans for each spectrum. The average acquisition time for each 2D spectral-spatial map was 150 min with the parameters listed above.

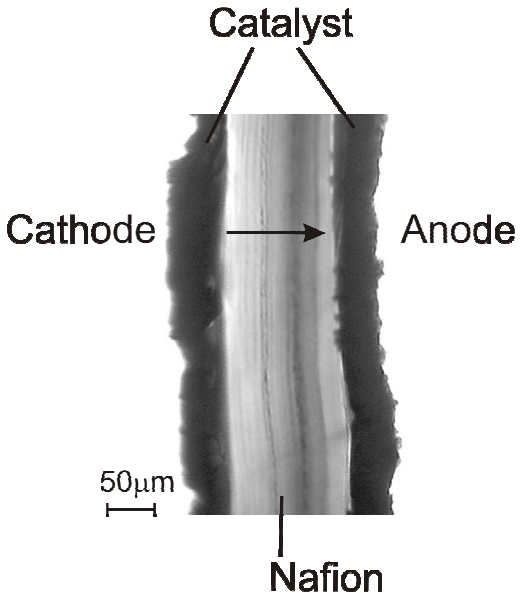

Figure S1. Optical image of the Nafion MEA cross-section. The data acquisition direction is indicated by the arrow. The catalyst layers were removed before the in–depth measurements.

OCV Operating Conditions. One common durability test for fuel cell membranes is to keep the cell at open circuit voltage (OCV). The OCV condition involves supplying hydrogen and oxygen to the fuel cell, as in normal operation, but no current is drawn. Since no oxygen is consumed under these conditions, there is a higher concentration of oxygen at the air/electrode - membrane interface available to diffuse through the membrane, and to form hydrogen peroxide at the anode (or at the Pt band). OCV conditions have been shown to result in a higher rate of membrane degradation.[2a]