Fe Mößbauer spectroscopy on the degradation of Fe-N-C catalysts induced by PEM-FC performance

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The polymer electrolyte membrane fuel cell (PEM-FC) is a promising device for the energy supply in cars. If the hydrogen is produced from renewable energy sources, an indeed zero-emission car could be realized. Today, platinum and platinum alloys are the state of the art material in PEM-FC. However, the high costs of platinum hinder a breakthrough of the FC technology. As most of the platinum is required for the sluggish oxygen reduction reaction (ORR) the replacement of platinum by a cheap non-precious metal catalyst (NPMC) should enable enormous cost reduction. Especially during the last decade, Fe-N-C catalysts have proven to be a realistic alternative for the ORR. Today, they reach power densities of about 65% of standard platinum catalysts (0.3 mg\textsubscript{Pt} cm\textsuperscript{-2})\textsuperscript{[1]}. The most significant problem that still accounts for these NPMC is related to their low long-term stability. It is assumed that an oxidation of the carbon support and/or a direct degradation of the active sites are at the origin of the considerable activity losses. With respect to the active sites, (i) a leaching of the metal centers from the N\textsubscript{4} coordination environment (irreversible degradation) or (ii) a change of the electronic state causing a decrease of the turn-over frequency are the most likely degradation scenarios\textsuperscript{[2]}.  

\textsuperscript{57}Fe Mößbauer spectroscopy has proven a powerful technique for the characterization of iron sites in Fe-N-C catalysts with respect to their oxidation and spin states as well as their coordination environment\textsuperscript{[3-7]}. In this work we will present our recent results on Mößbauer spectroscopy for the characterization of the degradation behavior in PEM-FC.

References: