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Effect of plasma treatment on the properties of Fe- and Co- based electrocatalysts

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Plasma-assisted methods are widely used for the modification of catalysts. By using plasma, it is possible either to improve the catalytic performance of materials or to create new catalyst materials. A plasma treatment of surface is also known as a versatile approach to improve the wettability of materials. These features help achieve a desirable metal-support interface in catalysts. The plasma prepared catalysts or catalysts modified by plasma exhibit a higher activity, enhanced selectivity and better stability, compared to the catalysts prepared conventionally (by heat-treatment). It is known from the literature that highly active electrocatalysts can be obtained by heat-treatment (pyrolysis) of carbon supported iron and cobalt salts. Nevertheless, the thermal pyrolysis of catalysts precursors can lead to an unfavourable morphology of the material. This drawback can be overcome by the replacement of heat-treatment step by low temperature plasma treatment of precursors.

In this work we have applied a radio-frequency (RF) inductively coupled plasma for synthesis of Fe- and Co- based electrocatalysts. Iron acetate, iron oxalate, cobalt acetate and cobalt oxalate were used as precursors of catalysts. The catalysts were treated by Ar-, N₂- and NH₃ plasma for different time at different RF power. The relationship of the properties of the catalysts and the treatment parameters was studied in detail. The chemical composition, structure and surface morphology of the catalysts were characterized by X-ray photoelectron spectroscopy (XPS), X-ray diffraction analysis (XRD), atomic force microscopy (AFM) and Fourier Transform Infrared spectroscopy (FTIR). Rotating disk electrode (RDE) measurements were conducted to evaluate the electrocatalytic activity towards oxygen and hydrogen peroxide reduction reaction. The electrocatalytic properties of plasma treated catalysts were compared with commercial products.

Keywords

Plasma treatment of catalysts

Non-precious catalysts

Oxygen reduction reaction

Electrocatalysts

AFM