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Ammonia Tolerant Anodes for PEM Fuel Cells

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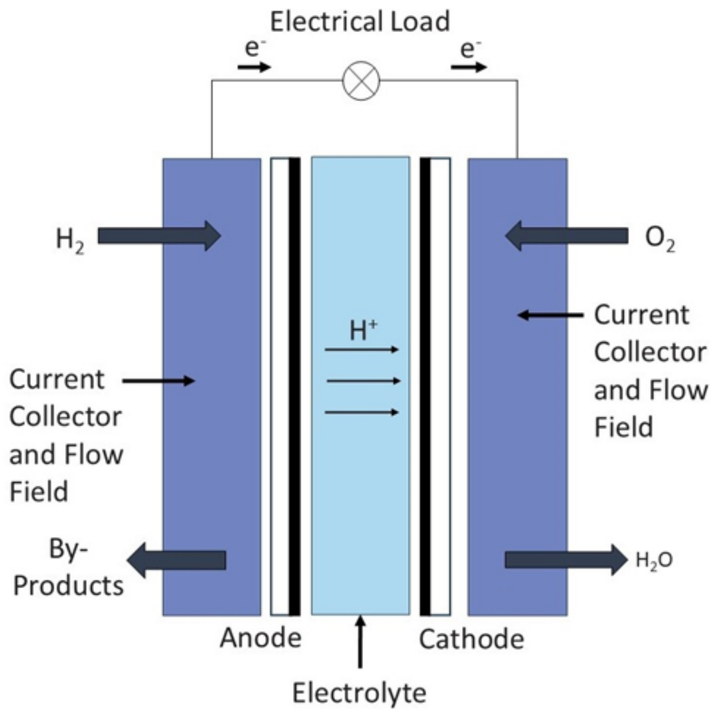
Background

Fuel cells are electrochemical devices that use hydrogen or other hydrogen rich fuels and oxygen from the air to produce electricity and heat from the reaction to produce water. [1]



At the anode:

$$H_2 \rightarrow 2H^+ + 2e^-$$

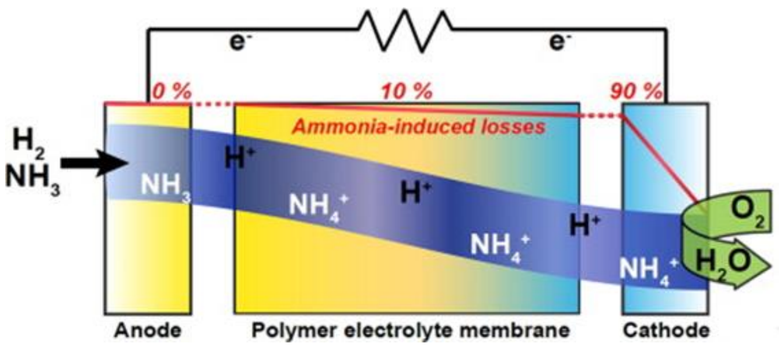
At the cathode:

$$\frac{1}{2}O_2 + 2H^+ + 2e^- \rightarrow H_2O$$

Overall:

$$H_2 + \frac{1}{2}O_2 \rightarrow H_2O + \text{heat}$$

Liquid vectors such as ammonia, are often used to avoid issues with storing pure hydrogen. However, when the ammonia is decomposed some unreacted ammonia can be present in the hydrogen fuel stream which can cause degradation in all parts of the cell. [2]

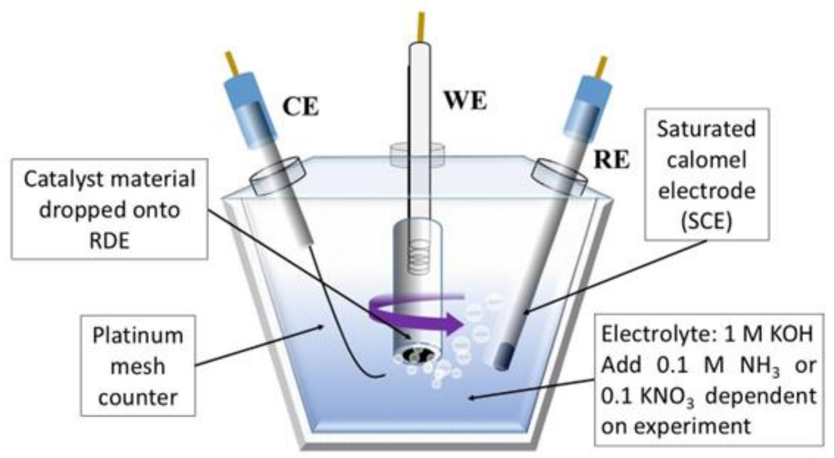


Aims and Objectives

The project seeks to increase the ammonia tolerance of polymer electrolyte membrane fuel cell anode catalysts by investigating palladium-based catalysts.

Experimental

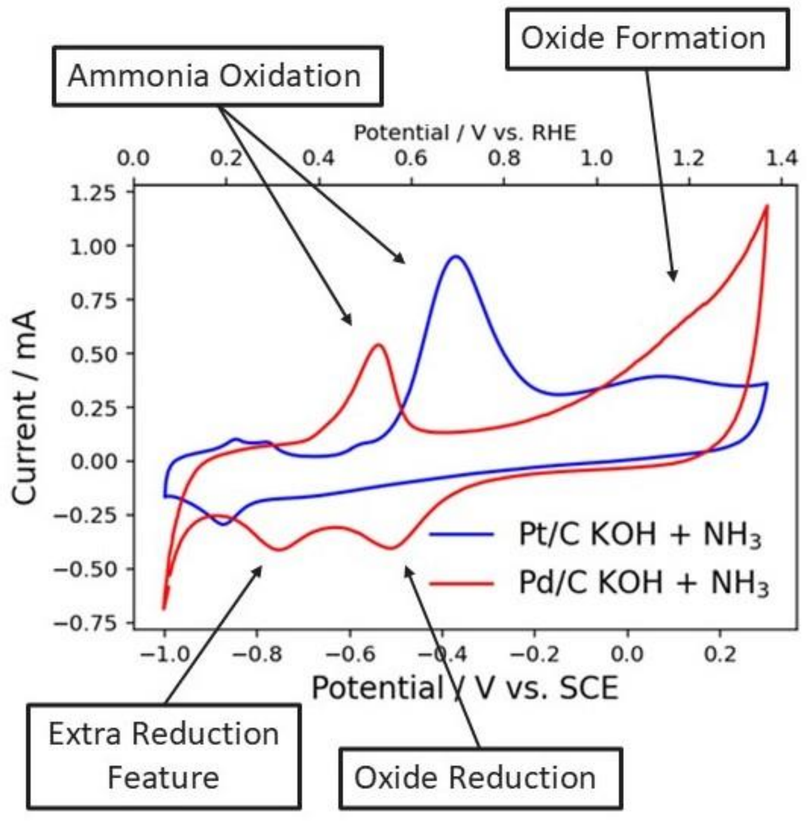
Current experiments ran in three-electrode cell. [3]



These experiments investigate the electrochemical oxidation of ammonia and reduction of nitrate.

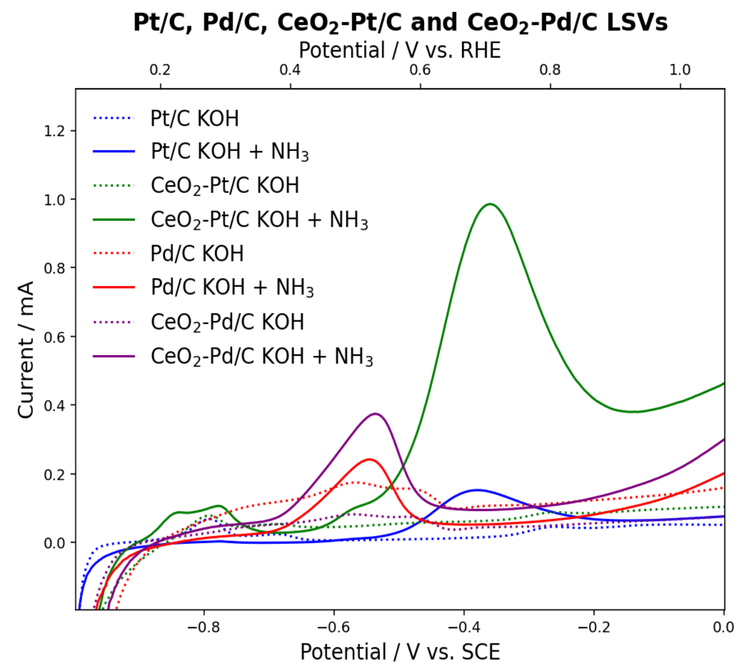
Results and Discussion

Cyclic voltammograms were run in 1 M KOH and 0.1 M NH_3 and the platinum and palladium show different features.

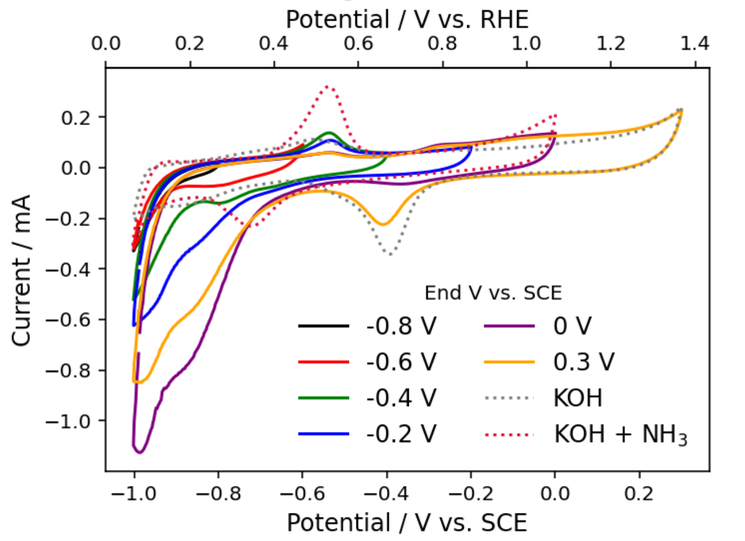


Results and Discussion cont.

The ceria modified catalysts show higher peak currents for ammonia oxidation.



Extra reduction feature in Pd CV likely nitrate reduction.



Nitrate reduction can form ammonia as seen by ammonia oxidation peak which could be due to palladium nitride formation.

Further Work

The next steps include using EXAFS to confirm the palladium nitride structure and employing NMR and mass spectrometry to identify intermediates and products from the reactions studied.

References [1] F. Leccese, The Open Fuel Cells Journal, 2013, 6, 1-20.; [2] A. Verdaguer-Casadevall et. al, Journal of Power Sources, 2012, 220, 205-210. [3] A. K. Samantara et. al, Metal Oxides/Chalcogenides and Composites: Emerging Materials for Electrochemical Water Splitting, 2019, pp. 5-9.

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