Organics Oxidation on Active and Selective Materials for Electrochemical Energy Conversion

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Abstract: The development of organic molecule-based fuel cells mostly relies on designing efficient anode materials capable of withstanding the poisoning effect of strongly adsorbed species at lower potentials, which prolongs the durability of the catalytic process. So as to obtain catalysts with excellent ability towards organic fuel oxidation, we employed a surfactant-less method, to synthesize PGM-based catalysts. Precious metal loading can be “diluted” by adding transition metals as co-catalysts, to single out different promotional effects in the activation and removal of adsorbed species from the electrode surface.

In this work, glucose was used as an organic fuel for its direct conversion to electricity and value-added chemicals. Physical characterizations of the nanomaterials used either as anodic (CO and glucose oxidation), or cathodic (oxygen reduction reaction - ORR) catalysts permitted to correlate their elemental composition and structure to their electrochemical performance in each half-cell. Afterwards, it was observed that the resulting direct glucose fuel cell delivered an open-circuit voltage and an output power that strongly depend of the nature of the catalysts, the metallic composition and the carbon substrate (Vulcan, reduced graphene oxide,..). Complementary analytical techniques were employed to probe the reaction processes involved in each compartment, enabling to determine the reaction products resulted from the glucose transformation and thereby, to understand reaction mechanisms of the glucose oxidation and the ORR over the studied electrode materials. Gluconate was found to be the main reaction product in the anodic side that showed a selective 2-electron conversion of glucose, while the ORR proceeded through a 4-electron pathway over the cathode catalyst.

This multivariate study coupling electrochemical techniques with spectroscopic and chromatographic methods decisively advances the research towards more effective electrochemical cogeneration devices such as solid alkaline membrane fuel/electrolyzer cells wherein bio-resources such as (oligo)saccharides are selectively oxidized towards high value chemicals.

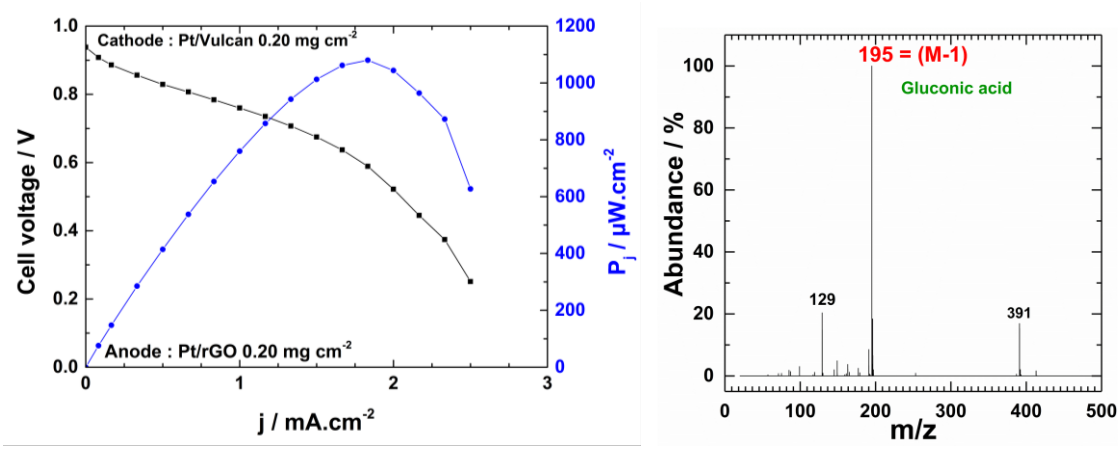

Figure 1. (left) Polarization curves of glucose/O_2 fuel cell in alkaline medium (Fumatech AEM). (right) LC-MS negative ionization mode of mass spectrum (M-1) for the main reaction product.

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