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Title of the dissertation: **Fe-N-C electrocatalysts from waste biomass for the oxygen reduction reaction**

Abstract

Fuel cells are devices able to convert chemical energy from a redox reaction to electric energy with low pollutants emission. They are a green alternative to current power sources, as they can be powered with energy from renewable sources and have potential application in the field of electronic devices as well as transportation. Their marketability is limited because of the high cost of catalysts needed to make the reaction happen and their low durability. For this reason, research is going on in both understanding the mechanism of oxygen reduction reaction, which is quite sluggish and is currently the limiting step of the reaction, as well as developing new electrocatalysts that can satisfy the requirements in performances, costs, and durability.

This work involved the synthesis of PGM-free (Platinum group metal free) electrocatalysts, namely Fe-N-C, which make use of non-noble metals coordinated by nitrogen atoms and supported on conductive carbon structure. The purpose is getting close to the performance of commercial Pt electrocatalyst and even surpass them to some extent. For the supporting carbon scaffold, biomass derived biochar has been selected and further engineered by chemical treatments, in order to obtain high value materials from common waste and create thus a circular economy giving some sort of new life to normally discarded wastes. Specifically, the biomass chosen is commercial tea leaves, thermally and chemically treated while the iron functionality is introduced by ball milling for 90 minutes. The structures obtained, widely characterized, show the porous and graphitic structure of the carbon, as well as the presence of iron. Electrochemical tests confirm the activity, stability and durability of these materials. It's clear that for ORR in alkaline environment, the biomass derived materials can outperform platinum in the long-term performance. The straightforward approach used for the synthesis is easy to replicate and scale up, and it is also possible to use it for other types of biomasses.

Graphical Abstract