# Electrocatalysts based on Pt and lanthanum oxide for the oxygen reduction reaction and application in PEM fuel cell

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## Summary

An alternative process for the preparation of Pt-$La_2O_3$/C electrocatalysts and application in PEM (Proton Exchange Membrane) for oxygen reduction reaction has been studied. Commercial Pt/C E-TEK was mechanically mixed with lanthanum oxide nanoparticles in various proportions and, using the thin porous coating technique on a rotating electrode, its efficiency was proved by voltammetry and chronoamperometry experiments. The application of this electrocatalyst as a cathode in a fuel cell unit has showed that the use of this method of preparation appears to be as viable as the other ones.

## Keyword

Electrocatalysis, oxygen reduction reaction, fuel cell, lanthanum oxide, Pt/C.

## Introduction

Of the various types of PEM fuel cell arouse great interest due to the lower temperature operation relating to the others. The most commonly used electrocatalyst is platinum, for both cathode and anode, but different cocatalysts have been used to increase the efficiency of fuel cell in order to reduce costs [1,2]. For that, the rare earths have been studied as cocatalysts or as substrate with promising results in the electro-oxidation of alcohols [3] and on oxygen reduction reaction (ORR) [4]. In both cases, enhanced efficiency observed in the use of rare earth oxides for alcohol electro-oxidation could be attributed to the bifunctional mechanism where Pt acts on adsorption of CO and rare earth oxides provides oxygenated species at lower potentials for oxidative removal of adsorbed CO [3]. For ORR, it was attributed to the oxygen storage capacity of $CeO_2$ and its ability to rapidly exchange oxygen [4].

## Results and Discussion

Typically electrocatalysts are prepared by different syntheses [5] from precursor salts to yield nanoparticles deposited on carbon substrate. However, in this work, Pt/C (E-TEK) and lanthanum oxide nanoparticles (Sigma-Aldrich) were mechanically mixed in different proportions and the activity for oxygen reduction reaction (ORR) determined by cyclic voltammetry and chronoamperometry. The Pt-La atomic ratios were determined by Energy-Dispersive X-ray (EDAX) analysis using a scanning electron microscope Phillips XL30 with a 20 kev electron beam and provided with EDAX DX-4 microanalyser (Table 1).

The experiments were carried out in a three-electrode electrolytic cell: platinum plate as auxiliary electrode, rotating electrode with the electrocatalyst as working electrode, and a reversible hydrogen electrode (RHE) as reference electrode.

**Table 1**. Pt:La atomic ratios obtained by EDAX

| Nominal Composition | Atomic ratio EDAX | |
|---|---|---|
| | Pt | La |
| Pt:La 90:10 | 89 | 11 |
| Pt:La 80:20 | 81 | 19 |
| Pt:La 70:30 | 71 | 29 |
| Pt:La 50:50 | 51 | 49 |

The cyclic voltammogram curves in 0.5 mol.$L^{-1}$ $H_2SO_4$ solution at room temperature and sweep rate of 10 mV.$s^{-1}$ do not have a well-defined hydrogen adsorption-desorption region. The increase of cathodic currents in the double layer was associated to the reduction of the lanthanum oxide in the catalyst. The efficiency of the electrocatalysts as cathode was verified in a fuel cell unit. The MEA (Membrane Electrode Assembly) was prepared with Nafion®117 and applied on carbon cloth with a brush, containing 1.0 mg.$cm^{-2}$ of Pt$La_2O_3$/C. The results showed that the electrocatalysts Pt:La 90:10 and 80:20 presented superior activity compared to Pt/C E-TEK electrocatalyst, as can be seen in Figure 1.

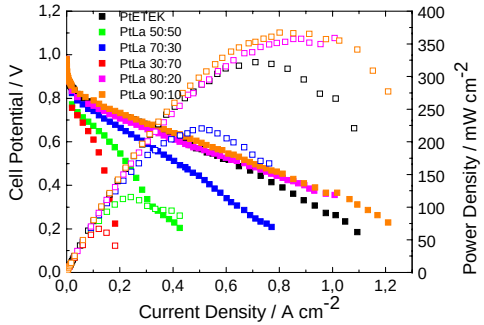


**Figure 1.** Electrochemical performance of PtLa/C electrocatalysts as cathode compared to Pt/C E-TEK electrocatalyst in a fuel cell unit, fed with hydrogen and oxygen.

## References

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