CARBON-SUPPORTED Ta-BASED ELECTROCATALYSTS FOR THE OXYGEN REDUCTION AND EVOLUTION REACTIONS

J.C. Ruiz-Cornejo[1], D. Sebastián[1], M.V. Martínez-Huerta[2], M.J. Lázaro[1]*

[1]Instituto de Carboquímica (CSIC), Miguel Luesma Castán 4, 50018 Zaragoza, Spain
[2]Instituto de Catálisis y Petroleoquímica (CSIC), Marie Curie 2, 28049 Madrid, Spain
*mlazaro@icb.csic.es

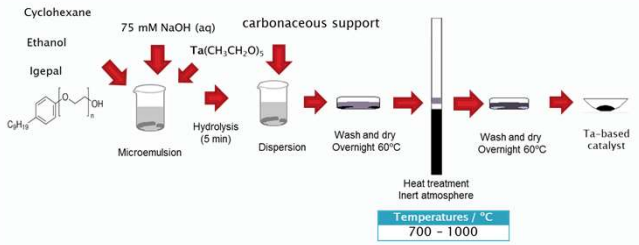
Introduction

Electrocatalytic materials with high efficiency for the main reactions on **bifunctional oxygen electrodes**, the oxygen reduction reaction (**ORR**) and oxygen evolution reaction (**OER**), are necessary for the development of new emerging electrochemical energy storage and conversion devices. Although some noble metals such as Pt and metal oxides (RuO_2, IrO_2) possess excellent activity as electrocatalysts, their high cost and instability hinder large-scale applications.

Tantalum-based materials have demonstrated to be active and robust electrocatalysts for the ORR in acidic environment[1]. They have an excellent electrochemical stability and become active for the oxygen reactions when the surface stoichiometry is tuned[2]. Carbon materials can act both as support and electron conductor phase. In this work, nanocomposites based on **tantalum sub-oxides** on carbon black have been investigated for the ORR and OER[3].

Materials and Methods

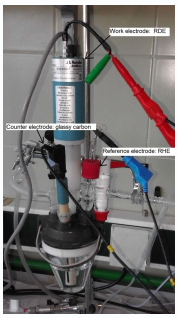
The synthesis is based on a microemulsion path.



The catalysts are labeled as TaOx/C followed by the annealing temperature (700, 800, 900 or 1000 ºC). The solid-state characterization was made by transmission electron microscopy (TEM) and X-ray diffraction (XRD).

The Ta-based catalysts were studied for the ORR and the OER in a three-electrode half-cell.

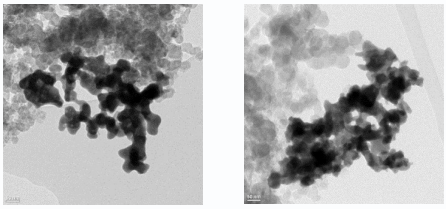
The electrochemical activity was studied by linear sweep voltammograms in O_2-saturated (ORR) and deareated (OER) 0.1 M NaOH electrolyte.



Results

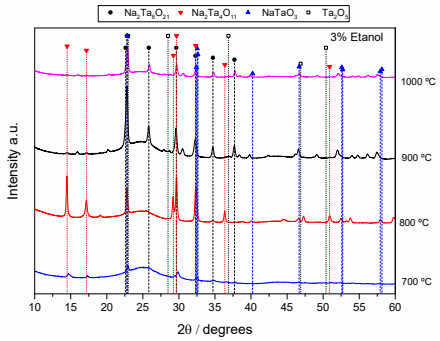
Physicochemical characterization

TEM images



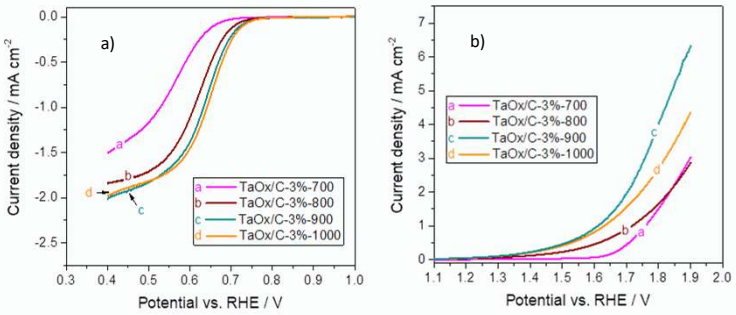
700 ºC 800 ºC

XRD patterns



Electrochemical characterization

Effect of the annealing temperature of the tantalum-based catalysts on the ORR/OER.



(a) ORR and (b) OER polarization curves for the Ta-based catalysts. Linear sweep voltammetries at 5 mV s^{-1}, 1600 rpm, 0.1 M NaOH, 45 µg cm^{-2} of Ta.

Conclusions

- The electrochemical response for the oxygen reduction and the oxygen evolution reactions in alkaline electrolyte (0.1M NaOH) was evaluated for the first time in this type of materials.
- The metal oxides are randomly mixed with carbon support, with their morphology changing from rounded (700 ºC) towards a prismatic and more ordered arrangement (800 -1000 ºC).
- High annealing temperatures resulted in catalysts showing the most promising bifunctional behavior despite the increase of particle size.
- The presence of $Na_2Ta_8O_{21}$ phase over other oxides/tantalates is also playing a relevant role to favor ORR and OER electro-activity.

References

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