

Electrospinning of Alcell lignin for the preparation of ORR electrocatalysts

Francisco José García-Mateos¹, Ramiro Ruiz-Rosas¹, Miguel García Rollán¹, Alejandro Ortega-Murcia², Emilia Morallón², Diego Cazorla-Amorós², José Rodríguez-Mirasol¹, Tomás Cordero¹

1 Universidad de Málaga, Departamento de Ingeniería Química, Andalucía Tech, Facultad de Ciencias, Campus de Teatinos s/n, 29010 Málaga - Spain

2 Instituto Universitario de Materiales. Universidad de Alicante, 03690 San Vicente del Raspeig, Alicante – Spain
ramiro@uma.es

Introduction

Carbon fibers are one of the components of the electrode assemblies used in fuel cells. They are usually prepared from polyacrylonitrile, a non-renewable synthetic polymer. Lignin is a highly abundant biopolymer that is obtained in large amounts as a byproduct in the papermaking and biofuel industries. It can be used as renewable precursor in the production of carbon fibers. In this sense, we have reported the production of carbon microfibers by coaxial electrospinning of Alcell lignin [1]. It is also possible to load platinum on these fibers, obtaining excellent catalysts for methanol oxidation [2]. In this work we report the production of electrocatalysts for the oxygen reduction reaction (ORR) via electrospinning of Alcell lignin/metallic salt solutions, enabling the replacement of synthetic polymers as raw material.

Experimental

Different metallic salts have been added to 1:1 lignin:ethanol solution and electrospun using a coaxial spinneret. Metal loaded carbon mats of different loadings have been obtained after the thermostabilization and carbonization of the electrospun fibers. The ORR activity of these samples has been studied using rotatory ring-disk electrode in 0.1 M KOH saturated with O₂.

Results and discussion

STEM-EDX images on Figure 1 shows that carbon fibers with loadings between 5 and 15 % of well-dispersed metal nanoparticles are successfully obtained through the proposed method. N₂ adsorption measurements reveals the development of wide mesopores during the carbonization process. These samples have outstanding ORR electroactivity, having water selectivity and onset potentials similar to commercial Pt-C catalysts, but using lower loadings.

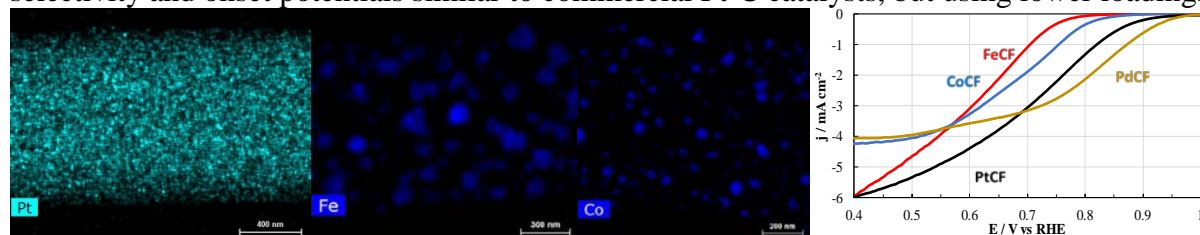


Figure 1. EDX mapping of different metal-loaded CFs, and LSV-ORR activity in 0.1M KOH

Conclusions

Synthesis of carbon fibers with supported metallic nanoparticles have been obtained by electrospinning of lignin/metallic salt solutions. The resulting carbon mats shows an excellent performance, confirming that these carbon mats are promising ORR catalysts.

Acknowledgements

The authors acknowledge the support by MINECO/FEDER (CTQ2015-68654-R and PTA2015-11464-I) and MICINN (RTI2018-097555-B-100).

References

- [1] R. Ruiz-Rosas, J. Bedia, M. Lallave, I.G. Loscertales, A. Barrero, J. Rodríguez-Mirasol, T. Cordero, The production of submicron diameter carbon fibers by the electrospinning of lignin, *Carbon*. 48 (2010) 696–705.
- [2] F.J. García-Mateos, T. Cordero-Lanzac, R. Berenguer, E. Morallón, D. Cazorla-Amorós, J. Rodríguez-Mirasol, T. Cordero, Lignin-derived Pt supported carbon (submicron)fiber electrocatalysts for alcohol electro-oxidation, *Applied Catalysis B: Environmental*. 211 (2017) 18–30.