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MODIFICATION OF THE MORPHOLOGY, POROSITY AND SURFACE CHEMISTRY OF LIGNIN-BASED ELECTROSPUN CARBON MATERIALS

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Abstract

Lignin is a biopolymer that can be found as the main component of plants. It is obtained as a coproduct in the papermaking and biofuel industries. Owing to its high carbon and aromatic content, high availability and reduced cost, it is an excellent precursor for the preparation of highly valued carbon materials. Electrospinning is a suitable top-down technique for the preparation of polymeric fibers using high voltage electrical fields and polymer solutions of proper viscosity and conductivity. Organosolv lignins, which are extracted from lignocellulosic biomass using organic solvents, are soluble in ethanol, obtaining a solution that matches the requirement of the electrospinning process. In this way, it is possible to produce lignin-based porous carbon fibers using a coaxial electrospinning device [1].

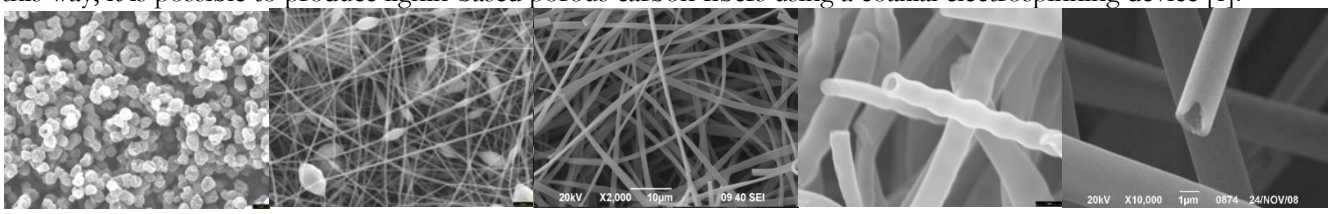

Fig. 1. SEM images of different lignin-based materials that have achieved using co-axial and tri-axial electrospinning.

This contribution summarizes our findings about the preparation of carbon materials with different morphologies and composition by processing lignin using electrohydrodynamic forces. Lignin spheres, beaded fibers, straight fibers, beaded tubes and straight tubes are obtained by using coaxial and triaxial spinnerets that allows the electrospinning of two or three different solutions at once [1], Fig. 1. Thermal stabilization in air is needed in order to avoid melting of lignin fibers during carbonization. Stabilization times of 48-96 hours are usually required in this step, decreasing the sustainability of the production process. Phosphoric acid can be added in small amounts in the lignin solution, shortening the time for achieve a successful thermostabilization of the fiber [2]. The carbonized materials show narrow microporosity and large surface area values (S_{BET} from 600 to 1000 m^2g^{-1}) and additional pore size and volume can be developed by controlled gasification. Moreover, small amounts of metallic salts can be solved in the lignin solution or feed on the outer or the inner surface of lignin fibers and tubes, allowing one-pot preparation of fibrillar carbon catalysts [3]. All these carbon materials have been successfully tested in different applications such as heterogeneous catalysis, energy storage and environmental protection [1-4], confirming that electrospinning is a powerful tool for maximizing the value of lignin as carbon precursor.

Acknowledgements

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References

[1] Lallave, M., Bedia, J., Ruiz-Rosas, R., Rodríguez-Mirasol, J., Cordero, T., Otero, J.C., Marquez, M., Barrero, A., Loscertales, I.G., 2007 Filled and Hollow Carbon Nanofibers by Coaxial Electrospinning of Alcell Lignin without Binder Polymers, Adv. Mater. 19, 4292–4296.

[2] García-Mateos, F.J. Berenguer, R., Valero-Romero, M.J., Rodríguez-Mirasol, J., Cordero, T., 2018. Phosphorus functionalization for the rapid preparation of highly nanoporous submicron-diameter carbon fibers by electrospinning of lignin solutions, J. Mater. Chem. A. 6, 1219–1233.

[3] García-Mateos, F.J. Cordero-Lanzac, T., Berenguer, R., Morallón, E., Cazorla-Amorós, D., Rodríguez-Mirasol, J., Cordero, T. 2017. Lignin-derived Pt supported carbon (submicron)fiber electrocatalysts for alcohol electro-oxidation, Applied Catalysis B: Environmental. 211, 18–30.

[4] Berenguer, R., García-Mateos, F.J., Ruiz-Rosas, R., Cazorla-Amorós, D., Morallón, E., Rodríguez-Mirasol, J., Cordero, T. 2016. Biomass-derived binderless fibrous carbon electrodes for ultrafast energy storage, Green Chemistry 18, 1506–1515.