NOVEL LIGNIN-BASED FIBROUS CARBON MATERIALS

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Lignin is (and will be) an important co-product in many lignocellulosic biomass-derived industries, such as pulp and paper mills (and the future biorefineries, when the concept of bio-economy be developed). The development of high-value products from lignin could mean a significant opportunity to reduce the associated costs and the environmental impacts of these industries [1]. In this sense, a new method to produce novel sub-micrometer carbon fibers and interconnected fibrous carbon webs materials (FCMs), showing unique advanced properties for different applications, by electrospinning [2] of phosphorous-containing lignin solutions is studied in this work.

The different FCMs were prepared by electrospinning of Alcell lignin solutions with and without P–containing compounds, followed by stabilization and carbonization at different temperatures. For comparison purposes, equivalent lignin-based powdery carbon materials (PCMs) were also prepared from lignin powder without the electrospinning step. The different samples were characterized by N_2 and CO_2 adsorption, SEM, TEM, XRD, Raman, XPS, TPD and TG analysis.

In the absence of P-containing groups, electrospun carbon fibers are continuous and linear (Fig 1.a), and show a specific surface area of 700 m^2/g, much higher than that of carbon prepared in powdery shape (70 m^2/g).

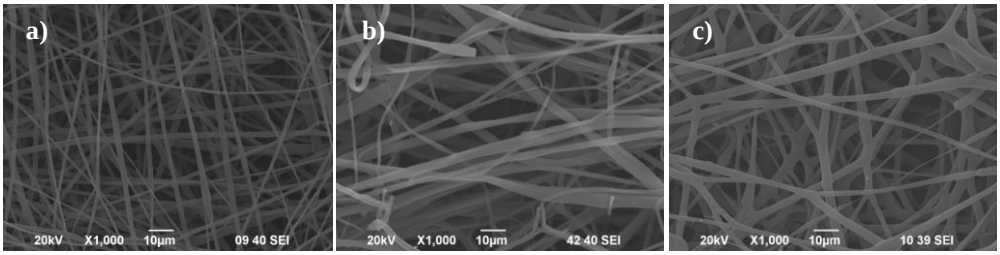

Fig. 1. SEM images of P-free carbon fibers (a) and P-doped carbon fibers (initial 30 wt% of P-containing compound) stabilized at 1 ºC/min (b) or 4 ºC/min (c).

The presence of P precursors in the lignin solution remarkably affects the electrospinning, stabilization and carbonization processes. By a suitable control of the stabilization heating rate, continuous and curly carbon fibers (Fig 1.b) or interconnected carbon fibrous webs (Fig 1.c) can be produced. In addition, the presence of 30wt% of P-containing compound in the lignin solution increases the specific surface area up to 1500 m^2/g and enhances the oxidation resistance of the FCMs at high temperatures, what have been found very interesting for different applications, such as catalysis, adsorption and energy storage and conversion. These properties cannot be obtained in lignin-based carbon powders, even by using an 80wt% of P-containing compound for their chemical activation (1100 m^2/g).

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References

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