Lignin activated carbon and green electrolyte as sustainable components for EDLCs devices

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Activated carbon-based Electrical double-layer capacitors (EDLCs) are the preferential choice given their unique combination of chemical inertia, electrochemical stability, conductivity, and specific surface area, together with the possibility to highly tune the textural properties of these materials in terms of surface moieties and pores size distributions [1]. To improve sustainability and reduce CO_2 footprint of the production of activated carbons, the pyrolysis of real bio-waste derived from local resources enables their valorization as well as the disengaging from fossil-derived resources.
For practical purposes, to enable an effective scale-up, biomass sources must be abundant and cheap [2]. Lignin stands out because it is the third most abundant natural polymer and one of the major wastes of anaerobic digestion processes and pulp and paper making industries [3]. The exponentially growing market of Electrical double-layer capacitors (EDLCs) requires the substitution of flammable, volatile, and toxic electrolytes with less dangerous and sustainable ones. The main limitation which is hindering the promises held by aqueous electrolytes is the low maximum cell voltage if compared to the organic ones. Therefore, the investigation of novel green electrolytes, such as DES and WiSE [4, 5], featuring an improved stability window compared to conventional aqueous electrolytes is critical to increasing the energy density of aqueous-based EDLCs.

Here we report a systematic study to scale up the production of Lignin Activated Carbon (LAC) generated by a one-step carbonization route starting from a real lignin waste, using $KHCO_3$ as a mild activating agent [3]. Different process pathways have been explored and the effect of the process parameter on the textural and chemical-physical and electrochemical properties of the activated carbon are analyzed and discussed.
Moreover, the optimized upscaled LAC produced and novel green electrolyte, have been exploited to produce an electrochemical characterize lab-scale EDLCs prototypes featuring 1.7 V of maximum cell voltage.

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