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Mesoporous carbon as sulfur support for lithium-sulfur batteries

Sarah David Pereira [1], Keiliane Silva dos Santos[1], Rayane Cristian Ferreira Silva[1], Paula Sevenini Pinto[2] and Ana Paula de Carvalho Teixeira[1]

[1]Departamento de Química, Universidade Federal de Minas Gerais, Belo Horizonte, Brazil
[2] Department B, Universidade Estadual de Minas Gerais, Divinópolis, Brazil
E-mail:anapct@ufmg.br

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Lithium-sulfur batteries are an alternative to ion-lithuim batteries, presenting high theoretical specific energy, satisfactory energy performance and low charging time. However, their use is limited by lithium degradation caused by the formation of lithium polysulfides during the charge/discharge process.[1] Mesoporous carbons are materials containing porous between 2 and 50 nm capable of adsorbing sulfur to serve as cathode in the batteries and, also, imprison polysulfides, preventing the loss of active components in the battery cell.[2]

In this work, a solvent-free soft template methodology was applied to synthesize the carbon material using tannin biomass was the carbon precursor, Pluronic F127 as surfactant and terephthaldehyde as the crosslinking agent. The reagents were mixed using a planetary ball mill and heated in argonium atmosphere up to 800 °C. The final material was milled and used for sulfur incorporation and characterization. Gas physisorption indicated medium pore size of 5.5 nm and BET surface area of 667 $m^2.g^{-1}$. Thermal analysis in oxidant atmosphere revealed thermal stability of the material up to 450 °C and Raman spectrometry presented D band, corresponding to disordered carbon and G band, referring to graphitic carbon.[3]

The sulfur incorporation was made using the diffusion by fusion method, in which the carbon material and the sulfur, in 1:1 proportion, were mixed using a high energy mill, dried without heat in a vacuum kiln and then put in a reactor for pressuring to 3 bar and heating up to 155 °C for 24 h. The incorporation efficiency was 94 % and the carbon material with sulfur was characterized by gas physisorption, resulting in a BET area of 1 $m^2.g^{-1}$, which was expected considering the presence of surfur in the pores. Thermal analysis in inert atmosphere showed the sulfur sublimation especially between 200 °C and 400 °C, leaving 47 % of carbon residue, indicating the creation of a material with 50% sulfur content to be applied in lithium-sulfur batteries. In a future stage, the materials produced will be tested for evaluation as electrodes for Li-S batteries.

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