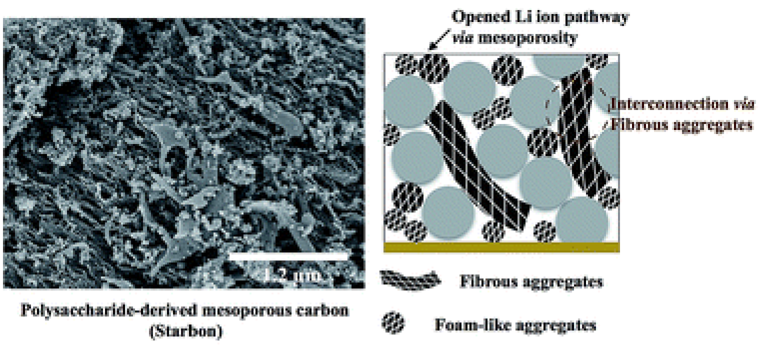
Starbon® Battery applications

Sustainable polysaccharide-derived mesoporous carbons (Starbon®) as additives in lithium-ion batteries negative electrodes

For the first time, polysaccharide-derived mesoporous carbonaceous materials (Starbon®) are used as carbon additives in Li-ion battery negative electrodes. A set of samples with pore volumes ranging from ≈0 to 0.91 $cm^3\ g^{-1}$ was prepared to evidence the role of porosity in such sustainable carbon additives. Both pore volume and pore diameter have been found crucial parameters for improving the electrodes performance *e.g.* reversible capacity. Mesoporous carbons with large pore volumes and pore diameters provide efficient pathways for both lithium ions and electrons as proven by the improved electrochemical performances of $Li_4Ti_5O_{12}$ (LTO) and TiO_2 based electrodes compared to conventional carbon additives. The mesopores provide easy access for the electrolyte to the active material surface, and the fibrous morphology favors the connection of active materials particles. These results suggest that polysaccharide-derived mesoporous carbonaceous materials are promising, sustainable carbon additives for Li-ion batteries.



https://doi.org/10.1039/C7TA08165K

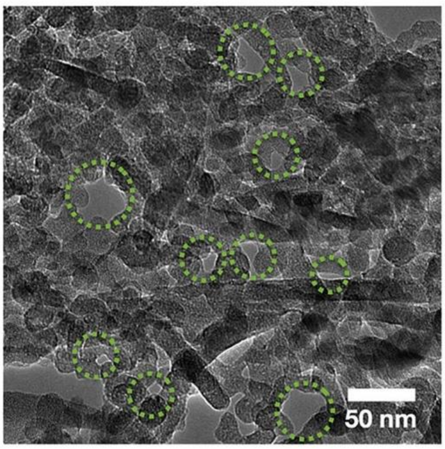
Monolithic mesoporous graphitic composites as super capacitors: from Starbons to Starenes®

In this study, we present a new class of monolithic mesoporous carbonaceous materials produced *via* the carbonisation of a mesoporous starch aerogel highly doped with graphite. Consecutive ball milling, microwave assisted gelation and carbonization treatment produced a high concentration of dispersed graphite. These treatments induce a strong interaction between the graphite particles and the developing carbonaceous matrix, including partial delamination of graphite and the merging of the nanoflakes into the carbonaceous structure. From a combination of SEM and TEM it was found that the graphite particles reduced in size to 24 and 37 nm, matching the pore wall sizes of the produced materials. From XRD, ball milling and heating helped reduce the number of graphene layers by 40%, with presence within the porous starch matrix reducing this a further 13%. The high degree of graphite dispersion/incorporation induces a pronounced increase in conductivity, and excellent capacitance retention, in excess of 10 000 charge–discharge cycles, offering a cost efficient and sustainably produced alternative to activated carbon based EDLCs and importantly, the resultant monolithic structures mitigate the need for additional binders.

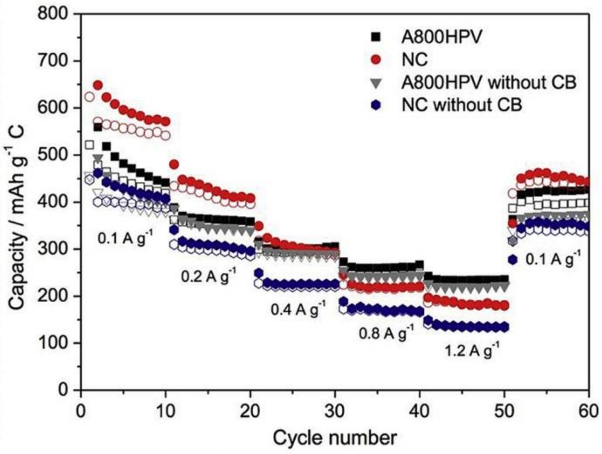
https://doi.org/10.1039/C7TA09338A

Alginic acid-derived mesoporous carbonaceous materials (Starbon®) as negative electrodes for lithium ion batteries: Importance of porosity and electronic conductivity

Alginic acid-derived mesoporous carbonaceous materials (Starbon® A800 series) were investigated as negative electrodes for lithium ion batteries. To this extent, a set of mesoporous carbons with different pore volume and electronic conductivity was tested. The best electrochemical performance was obtained for A800 with High Pore Volume (A800HPV), which displays both the highest pore volume (0.9 cm^3 g^{-1}) and the highest electronic conductivity (84 S m^{-1}) of the tested materials. When compared to a commercial mesoporous carbon, A800HPV was found to exhibit both better long-term stability, and a markedly improved rate capability. The presence of a hierarchical interconnected pore network in A800HPV, accounting for a high electrolyte accessibility, could lay at the origin of the good electrochemical performance. Overall, the electronic conductivity and the mesopore size appear to be the most important parameters, much more than the specific surface area. Finally, A800HPV electrodes display similar electrochemical performance when formulated with or without added conductive additive, which could make for a simpler and more eco-friendly electrode processing.



Alginic acid-derived mesoporous carbonaceous material (Starbon® A800)

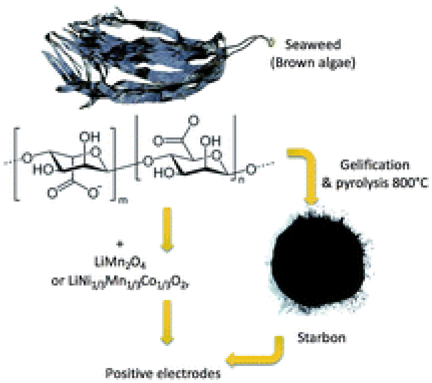


Excellent electrochemical performance as negative electrode lithium ion batteries

https://doi.org/10.1016/j.jpowsour.2018.10.026

Green electrode processing using a seaweed-derived mesoporous carbon additive and binder for $LiMn_2O_4$ and $LiNi_{1/3}Mn_{1/3}Co_{1/3}O_2$ lithium ion battery electrodes

Eco-friendly and cheap lithium ion battery electrode processing using a seaweed-derived mesoporous carbon additive (Starbon® A800) and binder (sodium alginate) was elaborated for $LiMn_2O_4$ (LMO) and $LiNi_{1/3}Mn_{1/3}Co_{1/3}O_2$ (NMC) lithium ion batteries. Compared to electrodes made using conventional formulations (*i.e.* Super P/PVDF) the 'green' electrodes can provide significantly 'upgraded' reversible capacity, almost reaching their theoretical capacity at low C-rate, likely due to good accessibility of lithium ions *via* the mesopores of the carbon additive. In addition, a synergistic effect was observed for a binary carbon additive system composed of Starbon® A800 with conventional carbon black (Super P), improving both the initial capacity and the rate capability of LMO and NMC electrodes.



https://doi.org/10.1039/C8SE00483H

Mesoporous Carbons from Polysaccharides and Their Use in Li-O_2 Batteries

Previous studies have demonstrated that the mesoporosity of carbon material obtained by the Starbon® process from starch-formed by amylose and amylopectin can be tuned by controlling this ratio (the higher the amylose, the higher the mesoporosity). This study shows that starch type can also be an important parameter to control this mesoporosity. Carbons with controlled mesoporosity (V_{meso} from 0.1–0.7 cm^3/g) have been produced by the pre-mixing of different starches using an ionic liquid (IL) followed by a modified Starbon® process. The results show that the use of starch from corn and maize (commercially available Hylon VII with maize, respectively) is the better combination to increase the mesopore volume. Moreover, "low-cost" mesoporous carbons have been obtained by the direct carbonization of the pre-treated starch mixtures with the IL. In all cases, the IL can be recovered and reused, as demonstrated by its recycling up to three times. Furthermore, and as a comparison, chitosan has been also used as a precursor to obtain N-doped mesoporous carbons (5.5

wt% N) with moderate mesoporosity (V_{meso} = 0.43 cm^3/g). The different mesoporous carbons have been tested as cathode components in Li-O_2 batteries and it is shown that a higher carbon mesoporosity, produced from starch precursor, or the N-doping, produced from chitosan precursor, increase the final battery cell performance (specific capacity and cycling).

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