Lecture 11. Carbon aerogel derived from sugarcane

Biomass derived carbon aerogels have become a major area of interest because of their novel structure and high potential for functionality which makes them potential candidates for environmentally friendly next generation carbonaceous materials. This mini-review discusses the synthesis route for developing porous carbon structures from renewable biomass such as cellulose, lignin, hemicellulose and chitosan through sol-gel processes, freeze-drying, supercritical drying, carbonization and activation. This review reorganizes biomass derived carbon aerogels according to their precursors by describing common features and possible applications of cellulose-based, lignin-based, hemicellulose-based, and chitosan-based aerogels. In addition, characterization methods such as Scanning Electron Microscopy (SEM), Brunauer-Emmett-Teller (BET) analysis, Fourier Transform Infrared Spectroscopy (FTIR) and X-ray Diffraction (XRD) are explained to give information about the surface morphology, pore structure and chemical constitution of the aerogels. Due to high surface area, lower thermal conductivity and high electrical conductivity, the biomass derived carbon aerogels are suitable for energy storage applications, catalysis and environmental application. This review also supports the role of BACAs for the development of new sustainable technologies and the reduction of negative environmental effects of conventional materials.

Biomass-derived carbon aerogels are eco-friendly alternative for traditional aerogels, and a novel class of materials derived from renewable resources. These materials, which are both economical and sustainable, are made from natural precursors such cellulose, lignin, hemicellulose, and chitosan. They are suitable for a variety of high-performance applications due to their lightweight structure, large surface area, and superior porosity. Biomass-derived carbon aerogels, in contrast to traditional aerogels that could use synthetic or non-renewable components are an example of green chemistry, which aims to reduce environmental impact while improving functional efficiency.

Li et al. (Li et al., 2015) obtained an aerogel-like carbon (ALC) based on sugarcane through a hydrothermal carbonization (HTC) and postpyrolysis process. The authors noted that the SSA of ALC, which has a subtle influence on the properties of ALC, can be fined tuned by the HTC process. Zang et al. (Zang et al., 2016) synthesized hollow carbon fiber sponges (HCFSs) by utilizing catkins as a biomass carbon source.

Table 2

Comparison of S_{BET} and application area of carbon aerogels from different biomass precursors

Type of carbon material	Raw material	SSA, m^2/g	Application	Ref.
Carbon aerogels	Natural cotton waste	1160	Adsorbents for wastewater clean-up	(Chen et al., 2015)
Carbon aerogels	Pomelo peel	466.0-759.7	Absorbent for removal of organic pollutants/oils	(Zhu et al., 2017)
Carbon aerogels	Cabbage leaves waste	536	For supercapacitors and oil/water separation	(Cai et al., 2018)
Carbon aerogels	Durian shell	735	For removal of organic pollutants	(Wang et al., 2017)
Carbon aerogels	Cocoon	714	As efficient catalyst for the oxygen reduction reaction in alkaline medium	(Li et al., 2018)
Carbon aerogels	WTP-PVA	1384	Adsorbent, catalyst supports and in energy storage devices	(Vazhayal et al., 2020)
Carbon aerogels	Wood	1124	For pressure sensing and energy storage	(Chen et al., 2020)
Carbon aerogels	Cellulose	-	For adsorption of diesel oil	(Yang et al., 2021)

N self-doped carbon aerogel	Chitosan	1480	For high-performance supercapacitors	(E et al., 2021)
N-O-P co-doped carbon aerogel	Abundant radish	1648.91	For high-performance supercapacitors	(Zhou et al., 2021)
A N-doped carbon aerogel	Cellulose	1196	For high-performance supercapacitors	(K. Zhao et al., 2022)
ALC	Sugarcane	390	Sensor, energy conversion and storage, and EMI shielding	(Li et al., 2015)
HCFSs	Catkins	438	Absorbent for oils and organic solvents	(Zang et al., 2016)

Literatures

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