Analysis of Pistachio Shell-Derived Activated Porous Carbon Materials for Hydrogen Adsorption

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Introduction

This study explores the use of pistachio shell-derived porous carbon (PC) as a sustainable and efficient material for hydrogen storage. Activated carbons (ACs), known for their narrow pore size distribution (<0.7 nm), are cost-effective and suitable for large-scale production.

Chemical activation enhances microporosity and surface properties. The hydrogen adsorption follows Langmuir-type I isotherm, increasing with pressure, aligning with experimental results.

The novelty of this work lies in the simplicity of producing ACs through a one-step activation process, aiming to significantly reduce preparation time and cost.

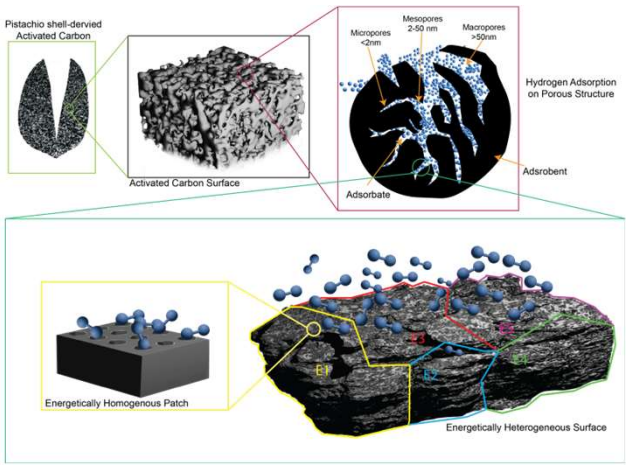

Fig. 1. Schematic of Hydrogen adsorption on Heterogeneous Porous Surface.

Methodology and Results

Fig. 2. Schematic of the preparation of AC using NaCl as activating agents.

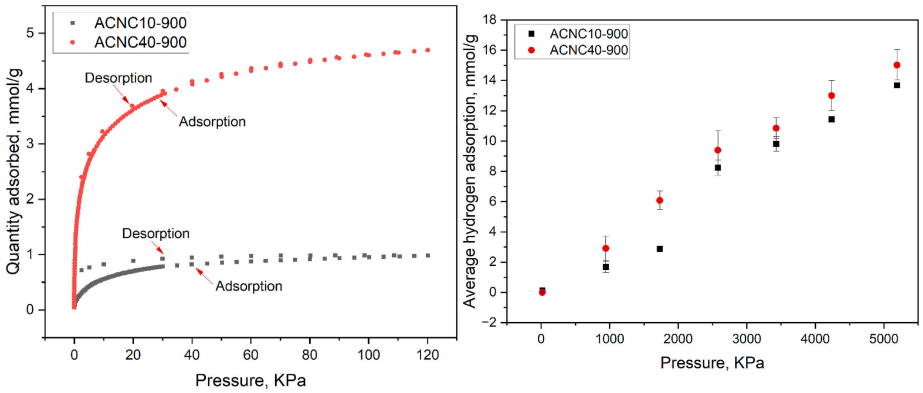

Fig. 3. Hydrogen adsorption/desorption of ACNC10-900 and ACNC40-900 at 77 K 1) low pressure 120 kPa 2) High pressure up to 5200 kPa.

Table 1. Hydrogen storage capacity of pistachio shells derived AC

Pistachio Shell_derived ACs	SSA (m^2 g^{-1})	Hydrogen Uptake Capacity (wt%)	Temperature (K)	Pressure (kPa)
10% NaCl activating agent	279	0.44	77	120
		4.77		5192
40% NaCl activating agent	579.4	1.99	77	120
		5.14		5192

Conclusion

This study developed cost-effective activated porous carbons from pistachio shell biomass using chemical activation with NaCl. The sample activated with 40% NaCl showed significant hydrogen adsorption capacity, up to 5.14 wt% at 77 K and 5192 kPa, nearing the U.S. DOE 2025 target of 5.5 wt%. The enhanced performance was linked to increased surface area and microporosity. While results are promising for low-temperature storage, achieving similar capacity at room temperature remains a challenge.

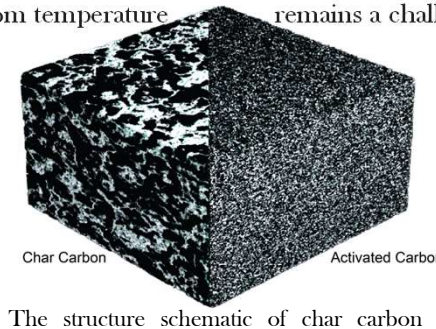

Fig. 4. The structure schematic of char carbon without activation and AC

Reference

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