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**CAS SCIFINDER® CARBON-BASED
ELECTRODE MATERIALS USE CASE**

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Optimizing the use of carbonaceous petroleum byproducts in rechargeable lithium batteries

As the world seeks to re-engineer its energy sources, storage systems have experienced a surge in research and development for, among others, application in electric vehicles and as an adjunct to renewable power generation.

Carbon-based electrode materials have been widely explored in electrochemical energy storage in rechargeable lithium ion batteries—the technology of choice for electric vehicles¹—due to their capacity, energy density, and power density.²

Carbonaceous materials such as graphite and petroleum coke are widely used in the anodes of lithium-based secondary cells.³ The graphitization process of coke and pitch for electrode materials is well-published,⁴ but there are challenges in developing carbon-based electrode materials with optimum cycle characteristics and structural performance.

Low tap density, low Coulombic efficiency, and prolonged charge-transfer distance across the electrode can reduce performance based on practical packing densities and thicknesses, limiting the ability to achieve high energy and power densities.^{5,6} However, assembly strategies have been developed that realize synergies between primary carbon nanostructures and advanced carbon architectures in high-performance electrodes.⁵

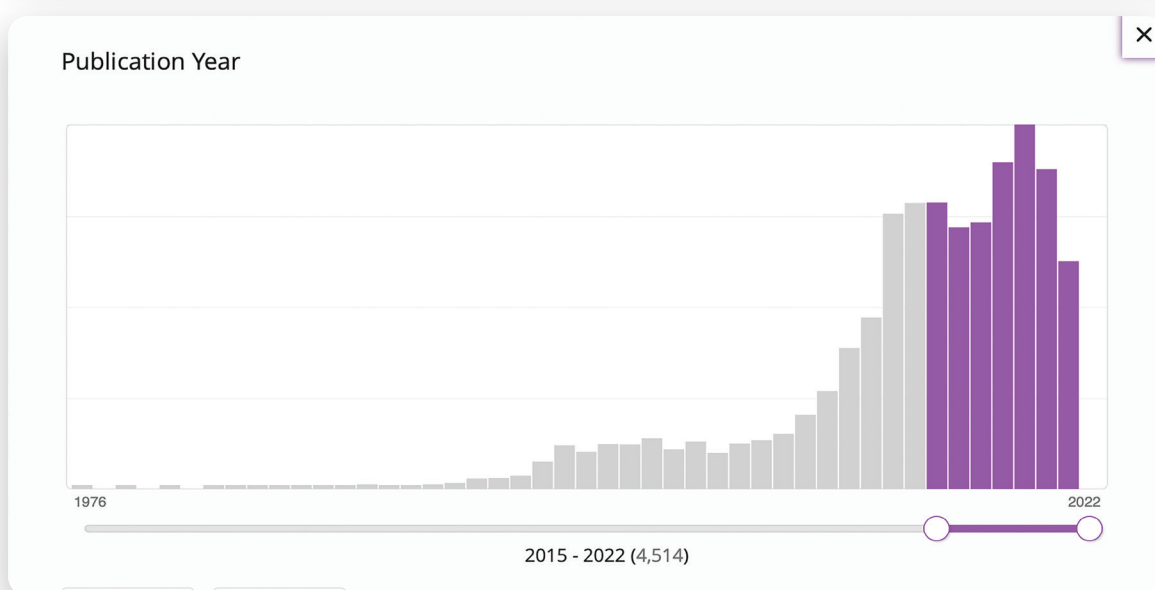
How can CAS SciFinder support your research in carbon-based electrode materials?

This example shows how you can gain new insight in this field and stay up-to-date on competitors with CAS SciFinder.



A reference search in CAS SciFinder on the topic "graphite for lithium secondary batteries" returns more than 15,000 research publications, more than half of which were published since 2015. This includes 4,514 patent documents since 2015.

The screenshot shows the CAS SciFinder interface. At the top, the search bar contains the query "graphite for lithium secondary batteries" with a search icon and a "Draw" button. Below the search bar, there are navigation options like "Substances", "Reactions", and "Citing". The main results section is titled "References (4,514)" and shows a list of results. The first result is highlighted, showing the title "Spheroidized graphite having excellent output characteristics, coated spheroidized graphite, anode, and lithium secondary battery" by Yamaji, Ryota; Madokoro, Yasushi; Obika, Motoharu; Matsuzaki, Akira; Masuoka, Hiroyuki; Suto, Mikito. The abstract mentions that the spheroidized graphite has excellent output characteristics when used as an anode material in a lithium-ion secondary battery. The interface also includes a "Filtering" section with filters for "Document Type: Patent" and "Publication Year: 2015 - No Max". A "Filter Behavior" panel on the left shows "Document Type" filters, with "Patent (4,514)" selected. A "Feedback" button is visible in the bottom right corner.



With the advanced functionality of CAS SciFinder, you can easily refine your results using the Concepts filter. These standardized scientific terms provide crucial insight into the core research in the result set.

The screenshot shows the 'References' section of a search result. At the top, it indicates 660 references. Below this, there are filters for 'Substances', 'Reactions', and 'Citing'. A 'Filtering:' section shows 'Document Type: Patent' and 'Publication Year: 2015 - No Max'. A 'Concept: 11 Selected' dropdown is visible. On the right, a 'Concept' list is expanded, showing terms like 'Lithium-ion secondary batteries (4,373)', 'Graphitization (298)', and 'Coke (162)'. The main content area shows a patent entry with the title 'Spheroidized graphite having excellent output characteristics, coated spheroidized graphite, anode, and lithium secondary battery' and a snippet of the abstract.

Among the most cited documents is Chinese patent 104577084 from Shenzhen BTR New Energy Materials, China's leading negative electrode manufacturer. BTR was the first to realize the industrialization of layered lithium manganese.⁷

The screenshot displays a patent document. On the left, 'Patent Information' includes: Patent Number CN104577084, Publication Date 2015-04-29, Application Number CN2015-10027926, Application Date 2015-01-20, and Kind Code A. The main text is the title 'Preparation of nano-silicon-graphite composite as negative electrode material of lithium ion battery' by Ren, Jianguo; Yue, Min; Huang, Youyuan; He, Xueqin. The abstract describes a method for preparing a nano-silicon-graphite composite as an anode material for a lithium ion battery, involving steps like hollow graphite preparation, silicon deposition, and carbon coating.



Substances (23)

1034343-98-0

Image Not Available

C
Graphene

Role: Nanomaterial, Physical, Engineering or Chemical Process, Technical or Engineered Material Use, Process, Uses

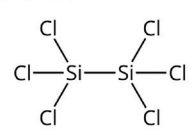
13465-78-6

$\text{H}_3\text{Si}-\text{Cl}$

ClH_3Si
Chlorosilane

Role: Physical, Engineering or Chemical Process, Process

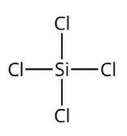
13465-77-5



Cl_6Si_2
1,1,1,2,2,2-Hexachlorodisilane

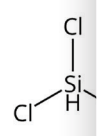
Role: Physical, Engineering or Chemical Process, Process

10026-04-7



Cl_4Si

10025-78-2



Cl_3HSi

Information about the various Concepts and Substances identified in the patent are displayed in the Reference Detail. This indexing allows you to explore additional information that may be related to your topic of interest.

Ball milling

Battery anodes

Carbon black
Modifier: Super-P

Role: Nanomaterial; Physical, Engineering or Chemical Process; Technical or Engineered Material Use

Carbon fibers
Role: Nanomaterial; Technical or Engineered Material Use

Carbon nanotubes

Carbonization
Modifier: high-temperature

Coal tar pitch

Hollow spheres
Modifier: **graphite**

Lithium-ion secondary batteries

Nanoparticles
Modifier: silicon

Petroleum pitch

Plasma-enhanced chemical vapor deposition

Polymers
Role: Physical, Engineering or Chemical Process

Pulverization

Feedback

Starting with a substance search in CAS REGISTRY®, the CAS substance collection, you can begin to focus specifically on the properties of carbon nanomaterials used in electrodes.

Filter Behavior

Filter by Exclude

Commercial Availability

Available (11)

Not Available (55)

Reaction Role

Product (13)

Reactant (7)

Reagent (6)

Catalyst (5)

Solvent (3)

Reference Role

Properties (58)

Physical, Engineering, or Chemical Process (50)

Process (50)

Preparation (47)

Substances (66) Sort: Relevance View: Partial

References Reactions Suppliers

7440-44-0

C

Carbon

1.1M References 26K Reactions 615 Suppliers

7782-42-5

C

Graphite

340K References 4,133 Reactions 133 Suppliers

1034343-98-0

Image Not Available

Notes: Honeycomb-shaped single-atom-thick sheets of sp²-hybridized carbon

C
Graphene

261K References 11K Reactions 170 Suppliers

7782-40-3

14762-74-4

14762-75-5

Feedback

References retrieved from the substance records can be narrowed by Substance Roles, powerful CAS indexing terms used to find precise information about substances in a publication. CAS SciFinder enables you to focus the search on carbon nanomaterials from petroleum byproducts applied to electrode materials.

Carbon nanomaterials-based supercapacitors are expected to have a hierarchical porous structure with balanced distribution of macropores, mesopores, and micropores.⁸ CAS SciFinder includes concepts related to nanometer properties, such as porosity.

The screenshot displays the CAS SciFinder interface for a search results page. On the left, a 'Filter Behavior' sidebar is visible, with the 'Substance Role' section expanded. The 'Substance Role' section includes the following options: 'Uses (12K)', 'Properties (5,711)' (checked), 'Preparation (3,498)', 'Nanoscale (3,086)' (checked), and 'Process (2,522)'. A 'View All' link is also present. The main content area is titled 'References (7,101)' and shows a list of results. The first result is highlighted with a yellow box and is titled 'Nitrogen-Doped Porous Carbon Nanosheets as Low-Cost, High-Performance Anode Material for Sodium-Ion Batteries'. The abstract text for this result is: 'N-doped porous carbon sheets were successfully fabricated by chem. activation (KOH) of polypyrrole-functionalized graphene sheets. Unique compositional and structural features endow the N-doped porous carbon sheets with superior Na ion battery (NIB) performance, i.e., a high reversible capacity (349.7 mAhg⁻¹ at a c.d. of 50 mA g⁻¹), a good cycling stability (260 cycles), and a high rate capability (50 mAhg⁻¹ even at a very high c.d. of 20 Ag⁻¹). The results demonstrate that the N-doped porous carb sheets presented are a promising candidate for the construction of low-cost Na ion battery syste...'. The page also features a 'Filtering:' section with 'Substance Role: 2 Selected' and 'Concept: 12 Selected', and a 'Search Within Results: (porosity or porous)' filter. At the bottom, there are buttons for 'Full Text', 'Substances (7)', 'Reactions (0)', 'Citing (476)', and 'Citation Map'.



Now that you have a result set of interest, the Alerts feature in CAS SciFinder can help you keep up-to-date on the latest research and competitor developments.

The screenshot displays the CAS SciFinder interface. On the left is a 'Filter Behavior' sidebar with sections for 'Document Type' and 'Substance Role'. The main area shows a search result for 'Nitrogen-Doped Porous Carbon Performance Anode Material' with a snippet of the abstract. A 'Save Search' dialog box is open, showing the search name 'Electrode carbon nanomaterials' and alert frequency options: 'No Alerts', 'As Available' (selected), 'Weekly', and 'Monthly'. The dialog also includes fields for 'Tags (optional)' and 'New Tag (optional)', a color selection bar, and 'Save' and 'Cancel' buttons. The top of the interface shows 'References (7,101)', sorting options, and filter buttons for 'Substances', 'Reactions', and 'Citing'.

CAS SciFinder powers your multidimensional research with industry-leading search and analysis technologies and content that can drive innovation from concept to commercialization. Backed by an unmatched view of the world's scientific literature, you can depend on CAS SciFinder to search faster and smarter, helping you accelerate research at every stage.

Learn more at cas.org

References

1. Xie, J., Lu, YC. A retrospective on lithium-ion batteries. *Nat. Commun.* **2020**, *11*, 2499. 2. Togonon, J., et al. Pure carbon-based electrodes for metal-ion batteries. *Carbon Trends* **2021**, *3*, 10035. 3. Loeffler, N., et al. Secondary lithium-ion battery anodes: from first commercial batteries to recent research activities. *Johnson Matthey Technol. Rev.* **2015**, *59* (1), 34-44. 4. Mazumder, B. Chapter Seven – Coal-derived industrial carbons. In *Coal Science and Engineering*; Woodhead Publishing India, **2012**; pp 344-451. 5. Wang, L., et al. Enhanced roles of carbon architectures in high-performance lithium-ion batteries. *Nano-Micro. Lett.* **2019**, *11*, 5. 6. Zhang, C., et al. Towards superior volumetric performance: design and preparation of novel carbon materials for energy storage. *Energy Environ. Sci.* **2015**, *8*(5), 1390–1403. 7. Guangming Government Online. Shenzhen BTW new energy and materials company limited. http://www.szgm.gov.cn/english/business/enterprises/content/post_4571938.html (accessed 2021-10-21). 8. Bai X., et al. Hierarchical porous carbon with interconnected ordered pores from biowaste for high-performance supercapacitor electrodes. *Nanoscale Res. Lett.* **2020**, *15*, 88.

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