



CHINA'S GRAPHITE MONOPOLY

By David Wojick, PhD



China has monopoly power over battery production worldwide

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Executive Summary

China is positioned to adversely influence lithium-ion battery production worldwide. China has monopoly control over processed graphite, an essential component of almost all lithium-ion batteries. Virtually all processed graphite, natural and synthetic, is made in China, then exported to the battery makers worldwide.

These batteries are used universally in electric and electronic devices from cell phones and watches to EVs and huge grid-scale backup batteries; there are numerous essential military uses, as well.

China is just now beginning to implement an export control program for processed graphite. By controlling exports, China could, to a significant degree, adversely influence much lithium-ion battery production, such as by raising prices to selected producers or even blacklisting entire countries.

Thus, the potential adverse impact of Chinese monopoly power is enormous. What they will actually do remains to be seen, but the threat is very real.

Note: This is a quick study, so the findings are necessarily very general.

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I. Basic data and technology

- a. Many electrical and electronic devices use lithium-ion batteries; indeed, it is possible that almost all these devices use this technology. Examples range from cell phones to electric vehicles (EVs) to enormous grid-scale backup batteries.
- b. Almost all these batteries (an estimated 98%) use processed graphite as an essential ingredient; for example, about 40% of the battery weight in an EV is graphite.
- c. China produces just under 100% of the processed graphite used worldwide to make lithium-ion batteries today.

Thus, China currently has a national monopoly on an essential component of the universally used lithium-ion batteries. This is potentially a position of great power, which could be used to benefit or harm the world or selected countries.

II. China's new graphite export control system

This national system began gearing up in December 2023. The basic system is very simple: any export of certain types of graphite now requires a permit issued by a central authority.

Two broad types are covered. The first is called "flaked graphite" and its products. Flaked graphite is the common form of natural graphite, and one of its primary products is the processed graphite used in lithium-ion batteries. The second type is synthetic graphite, and it is also used in these batteries.

Taken together, all the battery graphite China exports is now subject to central permitting.

III. The Chinese monopoly threat

While no individual Chinese graphite producing or exporting firm has monopoly power, the central permitting authority does have that power, if it chooses to assume it. Whether it can or not depends on the internal authority structure and policies of the Chinese government.

Given the far reaching, potential adverse consequences of such a monopoly, it is certainly worth considering this possibility. It would amount to central planning for strategic purposes.

How monopolies assert destructive power is well known from both theory and experience. China can easily raise prices to individual battery makers, graphite brokers, or entire countries. In particular, this export-permitting program could become part of a trade war with America, making us a likely target.

Since China is a major battery maker, it could go after its competitors. In principle, China could wipe

out a rival battery maker by simply not supplying the essential graphite, or it could simply raise the price to that competitor over time, which would be much harder to detect.

Whole markets might be targeted; for example, China could affect the EV market where serious competitors have existed or recently arisen in various countries. Driving up the price of an EV's battery increases the EV's price, as well. Simply driving up the price of EV batteries increases electric vehicle prices, making them uncompetitive with cheaper Chinese models.

More broadly, China produces a lot of different lithium-ion batteries, as well as devices that use them. Any of the many competitor markets could be targeted for monopoly action.

There are even geopolitical possibilities. Reportedly, many countries are looking to get into the EV battery making business. China could force such countries to cooperate in other ways as a condition of supplying them with graphite.

If the above measures seem far-fetched, keep in mind that a monopoly in essential supplies is a very powerful position, and thus a very tempting action to take, well short of open warfare, but still very effective.

IV. A curious lack of reporting on China's graphite monopoly threat

It is both surprising and curious that China's potentially powerful monopoly on processed graphite has received very little attention.

There have been several detailed analyses of supply issues with materials deemed critical to the "energy transition," but none we looked at even mentioned that almost 100% of processed graphite comes from China. The International Energy Agency (IEA) has a comprehensive assessment that discusses the critical role of processed graphite in detail. It also assesses China's place in various critical material supply chains but leaves out graphite.

The Organization for Economic Cooperation and Development (OECD) assesses critical materials issues, including export restrictions, but only considers raw materials that do not include processed graphite. The US Energy Department recently added graphite to its critical materials list, but they too only discuss raw materials.

Some of the relatively detailed news reports on the new Chinese export permits mention processed graphite but only in passing. None we have seen points out the monopoly powers that flow from this situation; rather, they too focus on raw graphite, where China has perhaps 70% of the supply market.

V. Attempts to break China's monopoly with new production capacity

Reportedly, a number of developing projects seek to build facilities to produce either processed natural graphite or synthetic graphite. Unfortunately, such projects are capital intensive and require extensive permitting, so progress has been slow. A few startup facilities making synthetic battery graphite are emerging, but their output is tiny compared to China's.

Moreover, the processing of natural graphite currently requires large amounts of hydrofluoric acid, which is both highly toxic and physically dangerous to handle. Thus, safety and environmental regulations and permitting might be an obstacle to building new production facilities in some countries.

Also, the predicted dramatic increase in EV production might increase the demand for battery graphite enough to offset the impact of new, non-Chinese production. This would have the effect of maintaining a de facto Chinese monopoly.

Of course, if China were to start to implement adverse monopoly actions, the need to break that monopoly would be much greater. Reaction could possibly include national action by affected countries; trade wars are not out of the question.

VI. Research that might break China's monopoly

A tremendous amount of research is going on in both graphite and battery technology. Some of this, if successful, might help break the Chinese monopoly, although it would take a relatively long time.

Obvious research areas include the following, all of which look to be active:

- Alternative materials to graphite;
- Cheaper ways to make synthetic graphite;
- Processing natural graphite without hydrofluoric acid.

VII. Technical discussion and references

Following are annotated quotations from and/or links to various technical sources that relate to some of the points made here. These sources can provide further information, including more links.

1. A succinct overview of graphite and Chinese domination, especially with reference to EVs.
"Graphite, Dominated by China, Requires the Largest Production Increase of Any Battery Mineral"

Institute for Energy Research, July 2023

<https://www.instituteforenergyresearch.org/international-issues/graphite-dominated-by-china-requires-the-largest-production-increase-of-any-battery-mineral/>

"China dominates the world's production and processing of graphite, which is the largest component by weight in electric vehicle (EV) batteries, and one of the most pure forms of carbon. Minerals.net describes it as follows: 'Graphite is a mineral composed exclusively of the

element carbon. Graphite has the same chemical composition as diamond, which is also pure carbon, but the molecular structure of graphite and diamond is entirely different."

2. China produces 100% of the graphite used in lithium-ion batteries. "GRAPHITE, A CRITICAL MATERIAL"

Northern Graphite Corporation, undated

<https://www.northerngraphite.com/resources/factsheets/factsheet.pdf>

"Graphite's demand is growing rapidly due to its critical role in electric vehicles (EVs), energy storage technologies, and fuel cells. Currently, China produces 70% to 80% of the world's graphite and 100% of the natural graphite used in LiBs."

3. Discussion of China's graphite export permit program. Unfortunately, there is some confusion between raw flake graphite and processed graphite, export of both of which are now controlled. Flake graphite is available elsewhere, but processed only comes from China.

"China's New Graphite Restrictions"

Center for Strategic and International Studies (CSIS), October 2023

<https://www.csis.org/analysis/chinas-new-graphite-restrictions>

"On October 20 and in response to the widened U.S. controls, China announced a new set of export restrictions on certain graphite products. As of December 1, Chinese exporters will be required to apply for permits to ship two types of the material, including 'high-purity, high-hardness and high-intensity synthetic graphite material and natural flake graphite and its products. 'The move comes two months after China restricted germanium and gallium products critical to semiconductor manufacturing, which came in the aftermath of another announcement by the Netherlands that it would support the United States' chip controls with its own equipment curbs."

"In both cases, China is leveraging its dominance of the global critical minerals and raw materials supply chain to respond to expanded economic security policies in the West. China produces 90 percent of the world's gallium and 60 percent of germanium. Likewise, it is the world's number one graphite producer and exporter and refines more than 90 percent of global graphite. However, while the August controls were aimed at the chips sector, China's graphite controls have more bite in electric vehicle (EV) battery manufacturing, since the material is used as a key input for anodes, the negatively charged portion of the EV battery."

4. Discussion of potential adverse impacts of Chinese export controls on graphite and other strategic materials. Many links to references.

"China's Export Controls on Critical Minerals – Gallium, Germanium and Graphite"

FTI Consulting, undated but includes links as late as December 2023

[https://www.fticonsulting.com/insights/articles/chinas-export-controls-critical-minerals-gallium-germanium-](https://www.fticonsulting.com/insights/articles/chinas-export-controls-critical-minerals-gallium-germanium-graphite#:~:text=China's%20Export%20Controls%20on%20Critical%20Minerals%20%E2%8)

[graphite#:~:text=China's%20Export%20Controls%20on%20Critical%20Minerals%20%E2%80%93%20Gallium](https://www.fticonsulting.com/insights/articles/chinas-export-controls-critical-minerals-gallium-germanium-graphite#:~:text=China's%20Export%20Controls%20on%20Critical%20Minerals%20%E2%80%93%20Gallium)

"On August 1, 2023, China began restricting exports of gallium and germanium, followed more recently, on December 1, with new export controls on high-grade graphite. China has justified these measures on the grounds of national security; however, gallium and germanium have broad applications in a range of industries, including electronics and fiber optics, while graphite anodes are an essential component of the lithium-ion batteries used in electric vehicles."

"The U.S. Department of Energy categorizes each of these materials as a critical material, highlighting their strategic importance to economic, energy independence and/or national security. While the initial market reaction to the restrictions on gallium and germanium was moot, China's action on graphite poses a significant risk to the stability of electric vehicle supply chains and highlights the fragility of dependence on critical materials from China."

5. There are a number of ongoing attempts to break, or at least reduce, China's monopoly on processed graphite. Regarding this 2021 report on one of the leaders, note that the point of the processing is to make what is called "spherical " graphite. Making the flake particles spherical is a complex, sophisticated technology.

"World's first battery-grade graphite producer outside of China"

PV Magazine, April 2021

<https://www.pv-magazine.com/2021/04/23/worlds-first-battery-grade-graphite-producer-outside-of-china/>

"Australia's Renascor Resources has confirmed it has raised AUD 15 million (\$11.6 million) to fund its Siviour battery anode material project up to the construction phase. The project will be the world's first integrated mine and purified spherical graphite operation outside of China."

"Purified spherical graphite is a key component of lithium-ion batteries, which is why a handful of companies across the world are racing to become the first producers outside of China, as the global wave of demand begins to peak. South Australian company Renascor Resources seems to have taken a lead in the race."

6. Discussion on making spherical graphite and Chinese dominance of the industry "*ABOUT SPHERICAL GRAPHITE ("SPG")*"

Fact sheet from Northern Graphite, undated

https://www.northerngraphite.com/_resources/media/SPG-Summary-2.pdf

"Spherical graphite is manufactured from flake graphite concentrates produced by graphite mines and is the battery anode material ("BAM") used in lithium ion batteries ("LiBs"). The first part of the process consists of micronizing, rounding and purifying flake graphite to produce uncoated spherical graphite ("uSPG")."

"Micronized and rounded material is then purified from approximately 94%Cg to 99.95%Cg using hydrofluoric and sulphuric acid, as impurities affect battery performance. (Cg means carbon in graphitic form as opposed to carbon atoms which are tied up in the molecular structure of other minerals). Wet chemical purification is a low-cost process in China,

approximately US\$300/t. However, large quantities of water are required to rinse the graphite, and the costs of neutralizing agents and proper environmental and health and safety practices with respect to handling HF can increase costs to US\$1,000/t. This is one of the reasons almost all uSPG is produced in China."

"The HF process can be used in the West, but HF is a very nasty substance and the costs are substantially higher. This has led many companies to look for alternative purification methods which usually involve high-temperature thermal treatment, chlorine, alkaline reagents or some combination of them. A number of junior graphite companies have announced purification processes, but it remains to be seen whether any of them have real solutions that can match the low capital and operating costs of the Chinese. This is a big issue with respect to developing a competitive SPG supply in the west. It also highlights that green electric vehicles have a component in their batteries which may not be so green."

7. The U.S. Department of Energy has Critical Minerals and Materials Program
<https://www.energy.gov/cmm/critical-minerals-materials-program>

It has published a major study of materials deemed critical to the U.S. energy sector. "*Critical Materials Assessment*," DOE, July 2023 https://www.energy.gov/sites/default/files/2023-07/doe-critical-material-assessment_07312023.pdf

Graphite is considered critical, and there is some discussion of why this is. However, in its production analysis, the DoE only considers flake graphite, so it misses the potential adverse impact of the Chinese monopoly on processed graphite.

8. The IEA has published an extensive study of materials critical to the "energy transition." Its analysts discuss the role of graphite in considerable detail, projecting enormous growth in the amount needed. They also analyze China's relative dominance with respect to producing a number of these critical materials, but curiously they do not include graphite.

"*The Role of Critical Minerals in Clean Energy Transitions*"

International Energy Agency, May 2021

<https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions>

9. The OECD published a lengthy analysis of transition-critical materials, including export restrictions. However, it is limited to raw materials and therefore misses the Chinese monopoly and restrictions on processed graphite.

"Raw materials critical for the green transition: Production, international trade and export restrictions"

OECD, April 2023

https://www.oecd-ilibrary.org/trade/raw-materials-critical-for-the-green-transition_c6bb598b-e