

A Secure, Canadian Deposit of Ultra-High-Purity Nuclear Graphite

NUCLEAR GRAPHITE

In 2015, [ASTM International](#) revised its standard for nuclear-grade graphite to graphite having a purity threshold of 99.995% carbon as graphite (Cg) and, critically important, less than 2 parts per million (ppm) equivalent boron concentration (EBC) (*source: ASTM Standard C1233-15*). Nuclear graphite must be free of neutron-absorbing material, in particular boron, which has a large neutron capture cross section.

A critical material for the construction of both historical and modern nuclear power reactors — in addition to numerous defense and aerospace applications — nuclear graphite is one of the purest materials manufactured at industrial scale. Graphite retains its physical properties, including strength, at exceedingly high temperatures.

THE PROBLEM: SYNTHETIC GRAPHITE

Historically, almost all graphite utilized for nuclear applications has been synthetic graphite (also known as artificial graphite or electrographite). Synthetic graphite is a man-made substance manufactured by the high temperature processing of amorphous carbon materials. The primary material used to manufacture synthetic graphite is petroleum coke. Petroleum coke, or pet coke, is the solid carbon residue that remains after the coking process is performed on petroleum residue.

The exact process used to manufacture synthetic graphite is varied and can be quite complex, in addition to being expensive and tremendously energy intensive (e.g. graphitizing the material in a furnace for 12 weeks at 2,800 °C). Recent advancements in the nuclear industry have exhausted the amount of synthetic nuclear-grade graphite available for purchase.

THE SOLUTION: NATURAL GRAPHITE

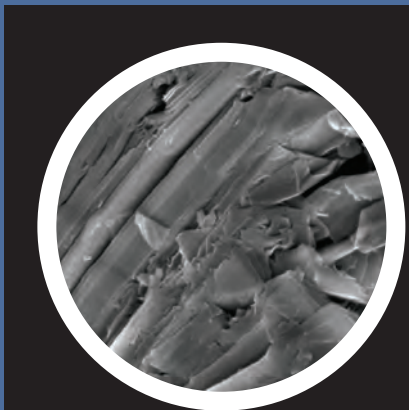
Research at world-leading nuclear science research laboratories such as [Oak Ridge National Laboratory](#) has demonstrated that natural graphite can be used as a substitute for synthetic graphite to produce nuclear graphite — and is preferred both from performance and price considerations. However, achieving both the stringent contaminant levels and the very small particle size at sufficient purity has, in the past, limited its use as the purification of those small graphite crystals has proven to be difficult. Purity aside, very few upgraded graphite products can pass the EBC requirement for nuclear use. Enter Canada Carbon.



The USS Virginia SSN-744 class nuclear-powered fast attack submarine

CANADA CARBON: NATURAL NUCLEAR GRAPHITE

Canada Carbon Inc. has 100% ownership of the Company's flagship [Miller HydroThermal Lump/Vein \(HLV\) Graphite Project](#) in Grenville, Québec, Canada (~60 miles west of Montréal). In October 2013, the Company demonstrated for the first time that the [Miller HLV graphite surpassed the purity and EBC threshold for nuclear graphite](#). As reported on May 1, 2015, [Canada Carbon achieved 99.9998% Ct purity utilizing commercially available nuclear graphite thermal upgrading, with a calculated EBC of only 0.72 ppm](#). On May 13, 2015, the Company announced that [Evans Analytical Group certified the Canada Carbon's Miller HLV graphite is of sufficient purity for nuclear applications](#).



SEM image of Canada Carbon's Miller Graphite (10,000 X magnification)

"I have been analyzing high-purity graphite for nuclear applications for many years at Evans Analytical, and these purity results for natural graphite are comparable to the purest natural graphite samples I have assayed, and compared to results published around the world. The high temperature heat treatment experiment clearly points toward unique physical characteristics of this Miller vein material. In all my years of analyzing graphite this behaviour is unprecedented."

Dr. Karol Putyera
Vice President, Purity Survey Analysis Services
[Evans Analytical Group](#)

CANADA CARBON: THE WORLD'S PUREST NATURAL GRAPHITE

Canada Carbon has been engaged in discussions with senior scientists at Oak Ridge National Laboratory since the fall of 2013 — beginning shortly after the Company first achieved nuclear purity for its Miller HLV graphite. These discussions provided Canada Carbon with targets and milestones, which helped the Company outline its research and development activities. During that time, the Company developed simple processing methods that surpassed the target purities provided to Canada Carbon by Oak Ridge National Laboratories.

Canada Carbon has successfully shown that its Miller HLV graphite can be concentrated by simple flotation at pilot-plant scale to greater than 99% Ct, and nuclear purity. By combining these results with the thermal upgrading to 99.9998% Ct of a randomly selected flotation concentrate sample produced from the pilot-scale program conducted by a commercial nuclear graphite processing facility, the Company believes that it has demonstrated proof-of-concept for the suitability of the Miller HLV graphite for nuclear applications. Canada Carbon has available several tonnes of Miller HLV concentrate from the pilot-plant program to quickly provide large quantities of its graphite for further assessment.

Oak Ridge National Laboratory, along with Idaho National Laboratory and other government agencies, are working towards the design and development of high-temperature, gas-cooled, graphite-moderated nuclear reactors, under a program supervised by the U.S. Department of Energy's Office of Nuclear Energy. Parallel research programs are underway on both prismatic and pebble-bed designs. A series of tests are currently underway to determine the optimal composition of nuclear fuel assemblies for this new generation of nuclear reactors.

Canada Carbon's ultra-high-purity Miller HLV graphite produced through thermal processing is also suitable for other high-technology applications, including aerospace and military end-uses. The Company has begun the process of submitting its nuclear graphite for further testing by the nuclear industry.

Qualified Person: Dr. Charbonneau, Ph.D., P. Geo #290, is an Independent Qualified Person under National Instrument 43-101, and has reviewed and approved the technical information provided in this document.

Canada Carbon has achieved **99.9998% Ct purity, with a calculated EBC of only 0.72 ppm**

NUCLEAR GRAPHITE USAGE

- Moderator
- Reflector
- Shielding
- Fuel Coating for Pebble Bed Reactors
- Numerous Defense and Aerospace applications

NUCLEAR GRAPHITE FUNCTIONALITY

- Radiation Moderation
- Thermal Conductivity
- Thermal Shock
- Structural Integrity
- Stability

NUCLEAR GRAPHITE PROPERTIES

- Small crystalline size
- Extremely low concentrations of:
 - Neutron-absorbing elemental contaminants
 - Oxidation-promoting elemental contaminants
 - Activation relevant isotopes
 - Metallic corrosion-relevant elemental contaminants
 - Fissionable elements
- Appropriate particle shape
- Appropriate particle-size distribution
- Stable crystal structure

Small Modular Reactors

The B&W mPower™ is an example of a proposed small modular reactor (SMR), designed by Babcock & Wilcox, and to be built by Generation mPower LLC — a joint venture of Babcock & Wilcox and Bechtel. The mPower™ is a Generation III+ light-water integral pressurized water reactor (iPWR), with the reactor and steam generator located in a single vessel. The reactor has a rated thermal output of 530 MWt and electrical output of 180 MWe. The reactor has an expected lifetime of 60 years.

Source: United States Nuclear Regulatory Commission

Photo: Babcock & Wilcox Nuclear Energy Inc.

Ellerton Castor, Chief Executive Officer

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