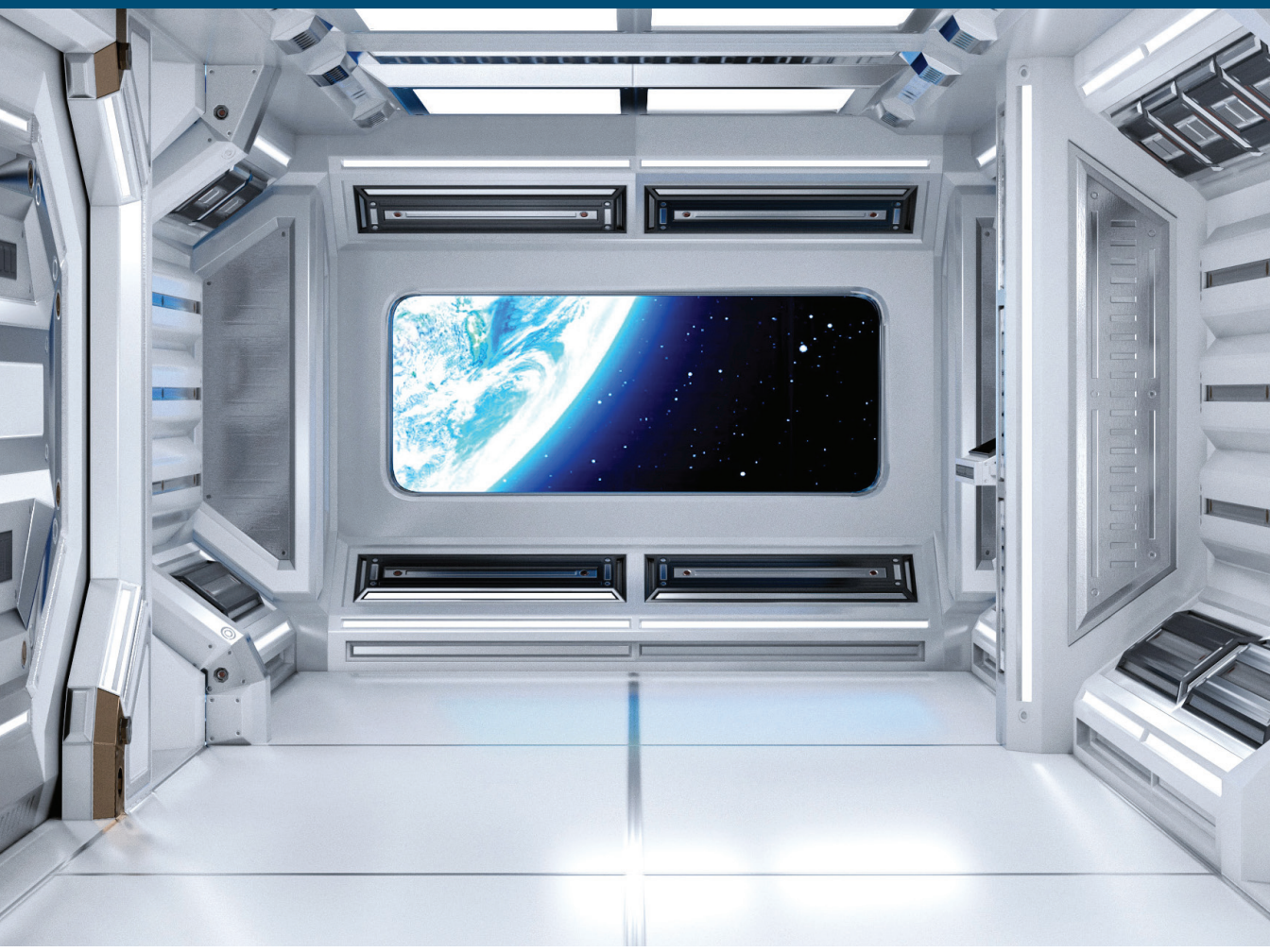
NRC·CNRC

NANOMATERIALS

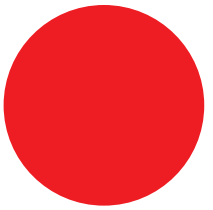
Strengthening the future of glass



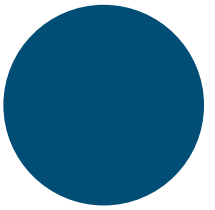
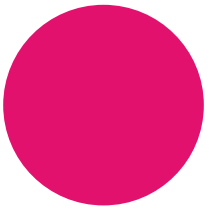
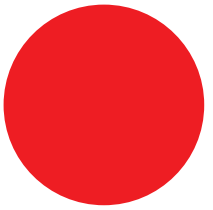
National Research Council Canada
Conseil national de recherches Canada

Canada

Boron nitride nanotubes have outstanding physical and chemical properties



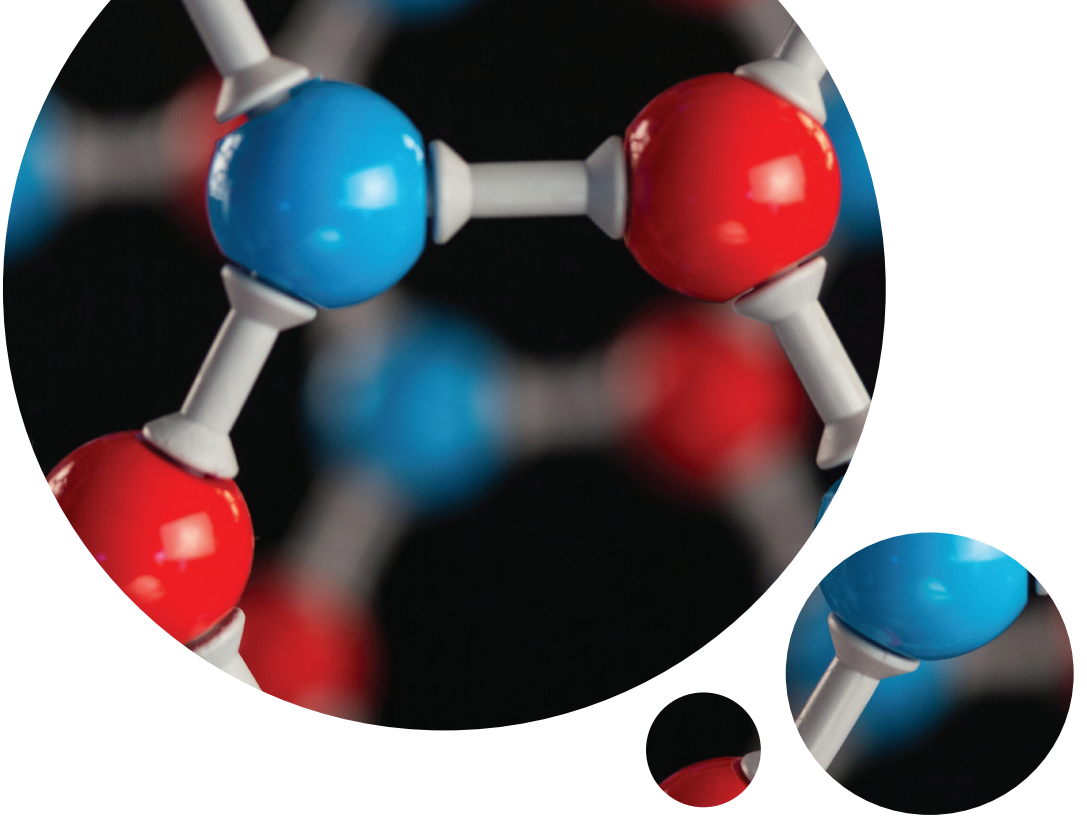





After 10 years of research and development in boron nitride nanotubes (BNNTs), scientists and engineers at the National Research Council of Canada (NRC) have developed a new, patented method to manufacture and purify BNNTs, and have explored a number of applications for this remarkable nanomaterial.

BNNTs: THEIR POTENTIAL IN GLASS AND TRANSPARENT COMPOSITES

While BNNTs share some similar properties to carbon nanotubes such as high strength, high stiffness, and high thermal conductivity, they also offer some unique application opportunities for reinforced glass or other transparent composites due to their lack of light absorption in the visible spectrum, high thermal stability, electrical insulation capability, piezoelectric nature, and their capacity for high neutron absorption.

Glass or other transparent composites reinforced with BNNTs could offer unique solutions in applications such as transparent armour, impact-resistant glass, scratch resistant glass, space, glass for touch screen devices – wherever enhanced transparent composites are needed.



ABOUT BORON NITRIDE NANOTUBES

BNNTs are seamless cylinders of an alternating boron and nitrogen hexagonal network. BNNTs have outstanding physical and chemical properties. In addition to being optically transparent to visible light, they exhibit high thermal stability (>900 degrees C in air), high strength, high stiffness, low density, are piezoelectric, electrically insulating and can shield against neutron radiation.

Our chemistry unlocks the potential of BNNTs for transparent composites. The NRC has developed methods to solubilize BNNTs in aqueous or organic solvents, and has developed diverse chemistry to directly integrate BNNTs in diverse composite matrices. This enables fabrication of optically transparent, reinforced glass and polymer composites, coatings, optical markers and sensors. The NRC has demonstrated that:

- BNNTs can be integrated successfully in soda lime glass and fused silica glass if proper processing is applied
- Early results show increases in hardness, modulus and scratch resistance of glass with the addition of BNNTs
- BNNTs remain intact after thermal processing

These early successes are paving the way for applications of BNNT composites summarised below that are not possible with carbon nanotubes (CNTs).

EXAMPLES OF COMPOSITES APPLICATIONS	CNTs	BNNTs
Transparent composites (or dye-able composites)	✗	✓
Extreme environment (high-temperature, harsh chemical) applications (e.g., thermal barriers, flame resistance, metal or ceramic processing)	Limited by CNT thermal stability	✓
Electrical insulation (e.g., cables, electronics packaging)	✗	✓
Electrical conductive composites (e.g., EMI shielding, static dissipation, Joule heating, strain sensing)	✓	✗
Mechanical reinforcement and structural composites	✓	✓
Thermal conductivity enhancement (e.g., heat dissipation)	✓	✓
Thermal management without electrical conductivity (e.g., improved processing and performance of printed electronics)	✗	✓
Piezoelectric sensing and energy harvesting	✗	✓
Neutron shielding	✗	✓


BNNT-H2O

THE NRC'S INNOVATIVE, PATENTED BNNT MANUFACTURING PROCESS

The NRC has the one of the largest production capacities in the world for BNNTs for R&D.

The NRC's new and scalable induction thermal plasma process uses a high cooling rate to create impeccably small-diameter (<10nm) BNNTs at high yields of over 25 g/h and at high purity. The entire process occurs at atmospheric pressure and requires no metal catalysts.

The process for production and purification of BNNTs is licenced to a commercial partner capable of scaling to your production needs.

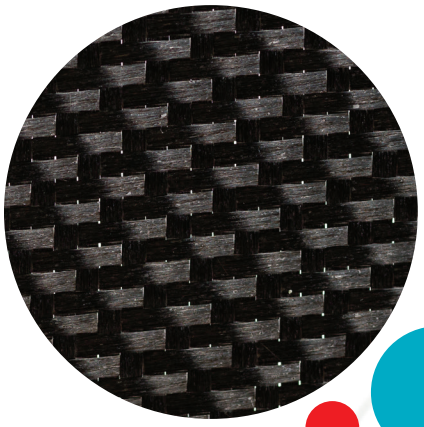
THE NATIONAL RESEARCH COUNCIL OF CANADA - NEXT-LEVEL SCIENCE, TECHNOLOGY AND RESEARCH

The National Research Council of Canada (NRC) is Canada's largest federal research and development organization.

The NRC has three key roles: advancing knowledge, business innovation and federal policy mandates.

Our strength is in our employees. We are 3,700 scientists, engineers, technicians, and other specialists, including 255 industry technology advisors.

Last year the NRC provided advice to 4,500 small and medium-sized enterprises (SMEs), we funded 3,500 SMEs, and we collaborated on R&D with 1,000 companies, including 152 hospitals, 72 colleges and universities, 34 federal government departments, 39 provincial/municipal governments, and 36 countries.



COLLABORATE WITH A LEADER IN BNNT RESEARCH

The NRC is currently seeking an innovative industrial partner(s) interested in further developing the application of BNNTs in glass and/or transparent polymer composites. The ideal partnership would consist of co-development activities with companies that have deep insight into specific product requirements, in these markets, along with in-house capabilities to develop, test and commercialize BNNT containing glass and/or polymer products. Specifically, the NRC is looking to enter into research partnerships to advance the use of BNNT in these applications and is ready to offer licensing options to intellectual property that might arise from any joint development work.

CONTACT

Roderick Paterson, Business Advisor
Security and Disruptive Technologies Research Centre
613-991-9047 · Roderick.Paterson@nrc-cnrc.gc.ca

nrc.canada.ca/research-centre

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