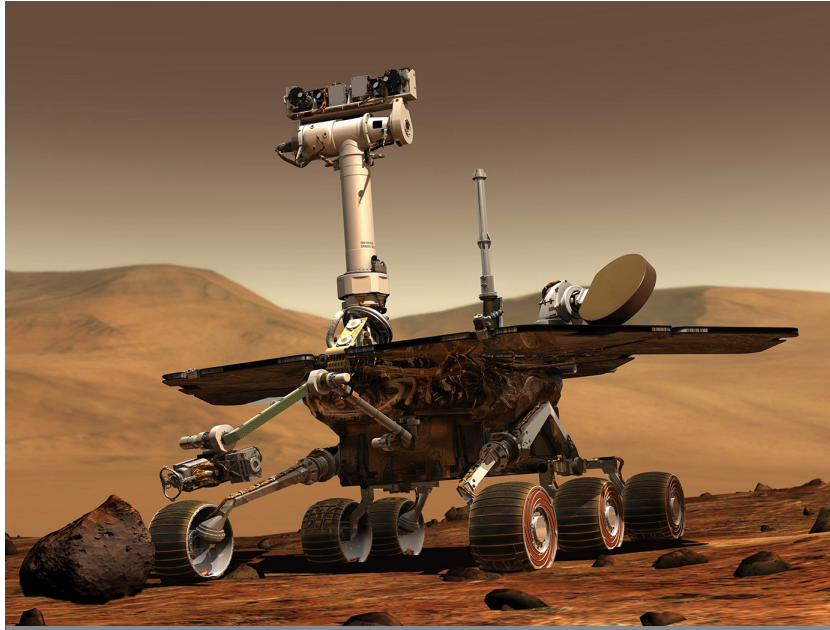




## TECHNOLOGY SOLUTION

### Materials and Coatings



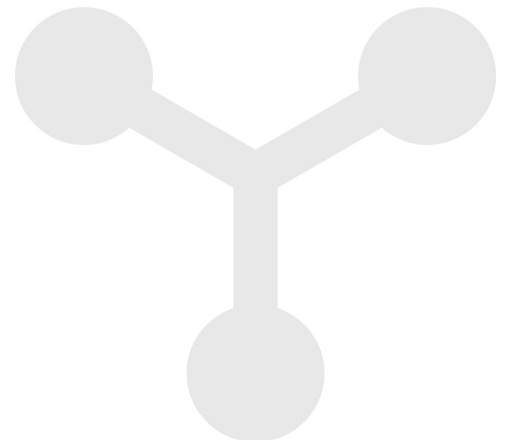
# New Methods in Preparing and Purifying Nanomaterials

[New processes greatly improve the properties of boron nitride nanomaterials](#)

Innovators at NASA's Glenn Research Center have made several breakthroughs in treating hexagonal boron nitride (hBN) nanomaterials, improving their properties to supplant carbon nanotubes in many applications. These inventors have greatly enhanced the processes of intercalation and exfoliation. Both processes are crucial in creating usable nanomaterials and tailoring them for specific engineered applications. In addition, Glenn's researchers have devised a means of fabricating exfoliated hBN-alumina ceramic composites, which have great potential as high-thermal-conductivity electrical insulators, as well as a new method to remove impurities from nanomaterials without causing damage to their structures. All of these advances have hBN nanomaterials set to transform applications such as heat sinks, electrical insulators, lightweight piezoelectric polymers for satellites and unmanned aerial vehicles, ceramic composites for jet engines, biomedical components, and radiation shielding technology.

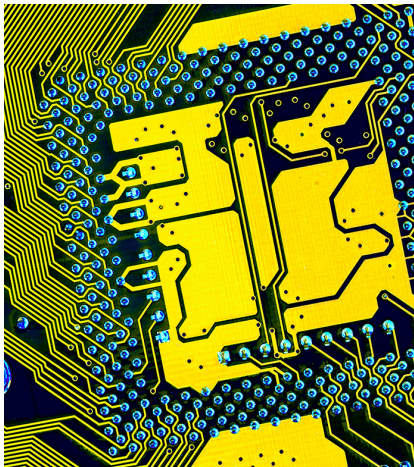
#### BENEFITS

- Durability: allows hBN nanomaterials to retain their strength even in much higher temperatures and higher stress conditions
- Unique properties: produces high thermal conductivity nanomaterials that are simultaneously effective electrical insulators, unlike similar state-of-the-art nanomaterials
- Versatility: permits materials to be tailored more closely to the needs of specific applications
- Outstanding piezoelectric properties: matrix composites made using hBN have improved performance generating energy from vibration and heat
- Simple manufacturing: simplifies process steps of intercalation and exfoliation, making it easier to produce larger volumes of ultra-pure nanomaterial



## THE TECHNOLOGY

Sometimes called white graphite, affordable and plentiful hBN possesses the same kind of layered molecular structure as graphite. In graphite, this structure has allowed next-generation nanomaterials like carbon nanotubes and graphene to be produced. With hBN, however, the process of converting the substance into boron nitride nanotubes (BNNT) has been too difficult to yield commercial quantities. Glenn innovators have created several new methods that could enable greater adoption of this unique nanomaterial. In the initial stage, the starter reactant is mixed with a selected set of chemicals (a metal chloride, for example) and an activation agent (such as sodium fluoride). This mixture causes hBN to become less resistant to intercalation. The intercalated product can then be exfoliated by heating the material in air, and giving the material a final rinse with a liquid-phase ferric chloride salt to dissolve any embedded impurities without damaging its internal structure. These efficiently exfoliated nanomaterials can be used to form advanced composite materials (e.g., layered with aluminum oxide to form hBN/alumina ceramic composites). Nanomaterials fabricated from hBN can also take advantage of the material's unique combination of being an electrical insulator with high thermal conductivity for applications ranging from microelectronics to energy harvesting. Glenn's innovations have enabled a significantly improved matrix composite material with the potential to make a significant impact on the commercial materials market.



Glenn's novel and effective process for fabricating hBN nanomaterials opens new territory for a variety of applications, including microelectronics



Glenn's hBN nanomaterials excel as electrical insulators and thermal conductors, an invaluable combination for energy-harvesting applications

## APPLICATIONS

The technology has several potential applications:

- Advanced composite materials for use in aircraft engines, coatings, and armor
- Microelectronics
- Piezoelectric devices, including sensors and robotics
- Thermal management
- Electrical insulators
- High temperature seals and gaskets
- Biomedical treatments and therapies
- Radiation and UV shielding devices
- Energy harvesting

## PUBLICATIONS

Patent No: 10,005,668; 10,000,419; 10,876,024

Patent Pending

[technology.nasa.gov](http://technology.nasa.gov)

More Information

National Aeronautics and Space Administration

**Agency Licensing Concierge**

**Glenn Research Center**

21000 Brookpark Road

Cleveland, OH 44135

202-358-7432

Agency-Patent-Licensing@mail.nasa.gov

[www.nasa.gov](http://www.nasa.gov)

NP-2016-06-2181-HQ

NASA's Technology Transfer Program pursues the widest possible applications of agency technology to benefit US citizens. Through partnerships and licensing agreements with industry, the program ensures that NASA's investments in pioneering research find secondary uses that benefit the economy, create jobs, and improve quality of life.

LEW-18970-1, LEW-18970-2, LEW-18970-3, LEW-18970-4, LEW-TOPS-107