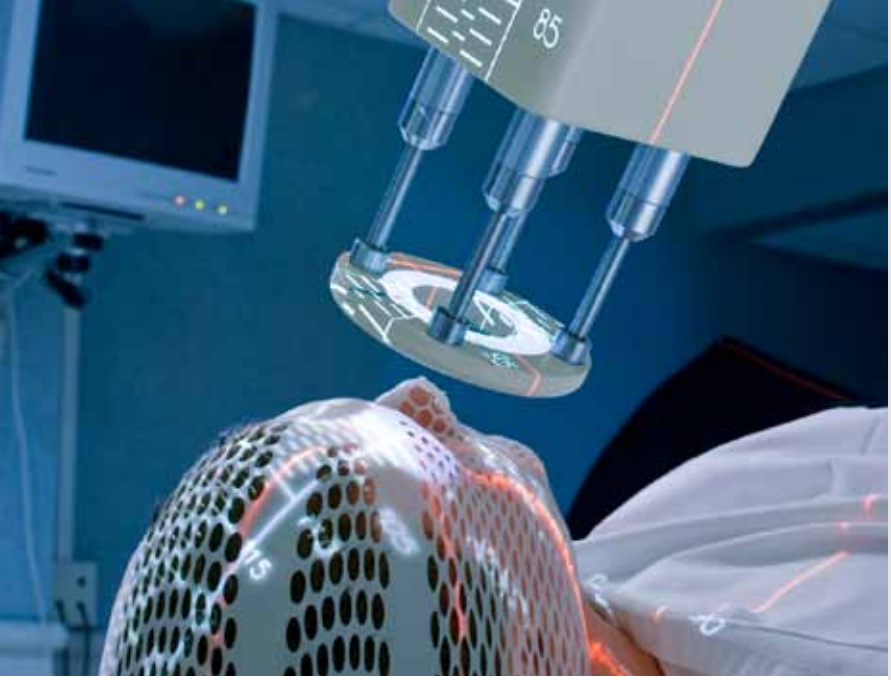


Neutron and Ultraviolet Radiation Shielding Films

Shielding films fabricated using boron nitride nanotubes (BNNTs) and BNNT polymer composites

NASA Langley, Jefferson Lab, and the National Institute of Aerospace have jointly developed a neutron shielding material using boron-containing nanomaterials, which include boron nanoparticles (BNPs) (0D), boron nitride nanotubes (BNNTs) (1D), and boron nitride nano-platelets (2D), as well as the polymer composites thereof. Effective shielding from ionizing radiation remains an important challenge in various fields, including defense and aerospace, medicine, and nuclear power installations. Shielding is required in order to protect both crew and equipment.

Benefits

- Enhanced neutron absorption – due to the presence of BNNTs in the polymer or ceramic matrix
- Transparency potential – BNNTs are white and optically transparent in the visible light range
- Thermal stability and mechanical robustness – able to function in harsh environments
- Less volume and weight as compared to purely hydrogen-containing or macroscopic BN particle-containing materials – due to the large neutron absorption cross section, along with the light weight and large surface area of BNNT
- Effective ultraviolet (UV) radiation shielding – BNNTs can strongly absorb and scatter light in the UV range

partnership opportunity

The Technology Gateway

The Technology

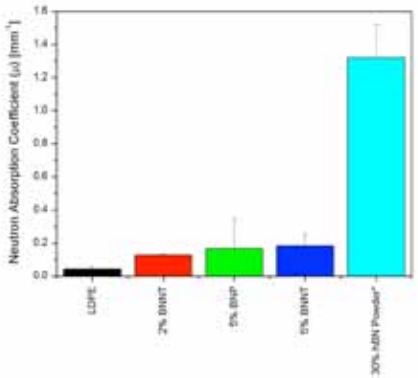
The current technology is a method to produce optically transparent neutron shielding windows by dispersing boron nitride nanotubes into a polymer matrix. The boron nitride nanotubes and sheets form a nanoscale filler, which is placed into a durable, hydrogen-containing polymer matrix. Durable aerospace polymers (e.g., polyimides) have already been developed for next generation aerospace vehicles and structures for weight reduction. The addition of BNNTs into the matrix leads to a composite that can improve structural integrity, as well as radiation shielding properties, with minimal weight penalty.

Boron nitride nanotubes have a low density (1.37 g/cm3), and boron has a large neutron absorption cross section of 710 barns (10B: 3835 barns). Nitrogen also has a fairly large neutron absorption cross section of 1.9, compared to carbon of 0.0035, which is another benefit for effective shielding. The large neutron absorption cross section, along with the light weight and large surface area of BNNT, enable effective shielding with much less volume and weight as compared to purely hydrogen-containing or macroscopic BN particle-containing materials.

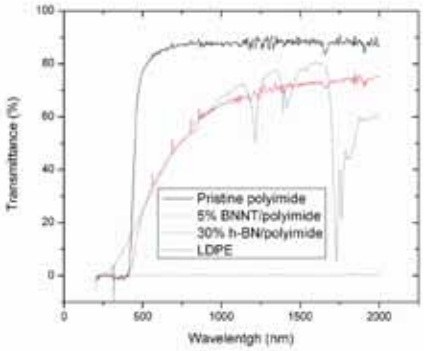
Boron nano-inclusion-containing fibers and films can be woven to form appropriate garment materials or can be used as a layer of radiation shielding garments.

Applications

- Radiation shield apparel – for use by workers in high radiation environments such as:
  - Aircraft crew and astronauts
  - First responders to radioactive material spills or a "dirty" nuclear bomb
  - Sailors in nuclear-powered submarines where months at a time are spent in a confined space
  - Crewmembers of future nuclear-powered spacecraft and space vehicles
- Nuclear medicine composites used to protect patients and equipment operators
- Optically transparent windows with effective UV radiation and neutron shielding – helmet visors or aircraft windows
- Conventional applications that require radiation shielding – automobiles, solar energy housing and buildings, cosmetics, clothing, blankets, helmets, etc.



Effectiveness of neutron shielding using low loading BNP and BNNT/polyimide composites compared to that of the state-of-the-art high filler volume fraction h-BN powder composites and low-density polyethylene (LDPE)



Effectiveness of neutron shielding using low loading BNP and BNNT/polyimide composites compared to that of the state-of-the-art high filler volume fraction h-BN powder composites and low-density polyethylene (LDPE)

For More Information

If your company is interested in licensing or joint development opportunities associated with this technology, or if you would like additional information on partnering, please contact:

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