SciDoc Publishers
Infer, Interpret & Inspire Science

OPEN ACCESS

International Journal of Nano Studies & Technology (IJNST)
ISSN:2167-8685

Boron Nitride Nanotubes for Space Radiation Shielding

Editorial

Mahdi Ghazizadeh, Joseph E. Estevez, Ajit D. Kelkar*

Joint School of Nanoscience and Nanoengineering, North Carolina A&T State University and University of North Carolina at Greensboro, USA.

***Corresponding Author**:
Ajit D. Kelkar,
Professor and Chairman Nanoengineering, Joint School of Nanoscience and Nanoengineering, Room Number 208-C, 2907 E. Lee Street, North Carolina A&T State University, Greensboro,USA. NC 27401.
Tel: (336)-285-2864
E-mail: kelkar@ncat.edu

Received: July 02, 2015
Published: July 07, 2015

Citation: Mahdi Ghazizadeh, Joseph E. Estevez, Ajit D. Kelkar (2015) Boron Nitride Nanotubes for Space Radiation Shielding. *Int J Nano Stud Technol.* 4(01e), 1-2. **doi: http://dx.doi.org/10.19070/2167-8685-150007e**

Soon after Armstrong`s left foot touched the surface of the moon in July 21, 1969, Mars seemed to be the next target for any future human space explorations [1, 2]. Although during these forty five years, advances in different fields of science like materials, electronics and space resulted in regular presence of satellites, space explorers and even human in space stations but any long travel including mission to the Mars has been limited by space radiation due to its effect on materials, electronics and astronauts [3, 4]. Space radiation can cause degradation in structural materials, introduce noise in electronic system and impose threat to astronauts` health due to biological changes, which could result in diverse diseases like cancer. In order to overcome these challenges, space radiation must be controlled and maintained under the acceptable limits and this can be achieved by using different shielding materials. Although shielding materials used in space structures designs till date are effective in controlling the radiation for short travels, their use for long duration mission may not be adequate, either due to drastically increase in weight or ineffectiveness of the material for long term travel. Therefore, scientific community and the National Aeronautics and Space Administration (NASA) have focused on finding new innovative radiation shielding materials for the future space explorations. This editorial presents an overview of one of such promising materials viz. Boron Nitride Nanotubes as a future space radiation shielding material.

Space radiation plays an important role in limiting any long duration travel due to its effect on astronauts, space structures and electronic equipment. These radiations are composed of ionizing and non – ionizing radiations. The primary concern in space exploration is ionizing radiation due to the particles high energy levels, which ionizes matter as it comes in contact. Ionizing radiation can be divided into three categories: Solar Particle Events (SPE), Galactic Cosmic Rays (GCR), and Radiation trapped in the Van Allen Belts around the Earth [5, 6]. GCR and SPE can also form secondary neutron radiation after interacting with matter. These secondary neutrons have the capability to cause the highest level of damage since it is difficult to block them by magnetic and electric fields. There are some materials which are being used to absorb or block these neutrons, like aluminum, but they are insufficient at preventing the maximum exposure allowed. The general guideline for radiation exposure to human is 25 rem in any 30 day period, 50 rem in a year and 100-400 rem for the duration of an astronaut's career depending on gender [7]. Therefore, it is essential to find new candidate materials with enhanced shielding capability, not only to protect the astronaut from space radiation but also to make long space duration human exploration possible.

Boron Nitride Nanotubes are nano size hollow tubes formed by Boron and Nitrogen atoms. BNNTs structure is similar to Carbon Nanotubes (CNTs) where each C–C bonds is replaced by B-N bond with almost identical bond length. Although this similarity suggests that BNNTs properties is similar to CNTs but there are differences which makes BNNTs superior choice for specific application including radiation shielding and organic photovoltaic packaging [7-11]. Apart from replacing Carbon atoms with Boron and Nitrogen atoms which is main reason for BNNTs radiation shielding capability; CNTs may be semiconductor or metallic mainly depending on nanotubes chirality (based on chirality, Nanotubes can be categorized into three groups of Armchair, Zig Zag and Chiral) while BNNTs has a specific band gap of 5.0–6.0 eV [10]. Also BNNTs offer better thermal stability, chemical stability and higher thermal conductivity compared to CNTs while it possesses almost similar mechanical properties [12-16]. One of the interesting characteristics of BNNTs for space application is that it offers both mechanical support and radiation shielding capability which makes it suitable to be used in structural materials of space crafts or even astronauts suits.The radiation shielding of BNNTs is mainly relies on B^{10} capability in capturing harmful neutrons due to its large neutron capture cross section while Nitrogen is also effective shielding component (with much less role comparing to B^{10}).

Although BNNTs unique combination of mechanical strength, thermal conductivity and stability and radiation shielding capability makes it a perfect choice for long duration space application but there are some challenges ahead which need to be addressed. One of the main concerns about BNNTs role as a reinforcement is transferring load from the matrix to them. As already seen in the case of CNTs, these nanostructures will not play as reinforcement unless proper surface bonding between matrix molecules and nanotubes atoms is achieved, otherwise CNTs or BNNTs act as a defect and degrade materials mechanical properties [17]. Another important question is the quantity of Nanotubes that can be incorporated into the matrix and how much it is needed for the effective radiation shielding for long duration space exploration. Different techniques can be adopted to address the concerns mentioned earlier. Some of these techniques include introducing functionalization which improves interfacial bonding between Nanotubes and matrix molecule [17], introducing hydrogenated BNNTs to improve the radiation shielding capability and interfacial bonding [18]; and use of CNTs or BNNTs in the form of fibril or yarn which can increase the volume fraction of nanostructure in the composite [19]. Although there is a long road ahead towards human`s long duration space exploration, BNNTs seems to be a promising materials for the successful future travel to Mars.

References

[1]. Spennemann DHR (2004) The ethics of treading on Neil Armstrong's footprints. Space Policy 20(4):279–290.
[2]. Spudis PD (1992) An Argument for Human Exploration of the Moon and Mars. American Scientist 80(3):269-277.
[3]. Parnell TA, Watts JW, Armstrong TW (1998) Radiation effects and protection for moon and mars missions. In Proceedings of the Sixth International Conference and Exposition on Engineering, Construction, and Operations in Space, Space 98:232-234.
[4]. Maurer RH, Martin MN, Roth DR (2008) RHarsh Environments: Space Radiation Environment, Effects, and Mitigation. Johns Hopkins APL Technical Digest 28(1):17.
[5]. Norbury et al. NASA LaRC Space Radiation Roadmap.
[6]. Howard Jr JW (1999) Spacecraft Environments Interactions: Space Radiation and its effects on Electronic Systems. 1-36.
[7]. Fay CC, Thibeault SA (2012) Radiation Shielding Materials Containing Hydrogen, Boron, and Nitrogen: Systematic Computational and Eperimental Study. 1-29.
[8]. Ravichandran J, Manoj AJ, Liu J, Manna I, Carroll DL (2008) A novel polymer nanotube composite for photovoltaic packaging applications. Nanotechnology 19:085712.
[9]. Chang CW, Han WQ, Zettl A (2005) Thermal conductivity of B–C–N and BN nanotubes. J Vac Sci Tech B 23(5):1883-1886.
[10]. Chen H, Chen Y, Li CP, Zhang H, Williams JS, et al. (2007) Eu-doped Boron Nitride Nanotubes as a Nanometer-Sized Visible-Light Source. Advanced Materials 19(14):1845–1848.
[11]. Harrison C, Weaver S, Bertelsen C, Burgett E, Hertel N, et al. (2008) Polyethylene/Boron Nitride Composites for Space Radiation Shielding. Journal of Applied Polymer Science 109(4):2529–2538.
[12]. Golberg D, Bando Y, Tang CC, Zhi CY (2007) Boron Nitride Nanotubes. Advanced Materials 19(18):2413–2432.
[13]. Chen Y, Zou J, Campbell SJ, Caer GL (2004) Boron nitride nanotubes: Pronounced resistance to oxidation. Applied Physics Letters 84(13):2430-2433.
[14]. Ciofani G, Raffa V, Menciassi A, Cuschieri A (2008) Cytocompatibility, interactions, and uptake of polyethyleneimine-coated boron nitride nanotubes by living cells: Confirmation of their potential for biomedical applications. Biotechnology and Bioengineering101: 850–858.
[15]. Hilder TA, Hill JM (2008) Theoretical comparison of nanotube materials for drug delivery. Micro & Nano Letters 3(1):18-24.
[16]. Estevez J, Ghazizadeh M, Kelkar AD (2013) Property Prediction of Single Wall Boron Nitride Nanotubes using MD Simulation. Proceedings of American Institute of Aeronautics and Astronautics. http://arc.aiaa.org/doi/abs/10.2514/6.2013-1856.
[17]. Ghazizadeh M, Estevez J, Zhang L, Kelkar AD (2013) Effects of Electrospun Fibers on the Mechanical and Thermal Properties of EPON 862-W Epoxy Resin System. SAMPE, Long Beach, California.
[18]. Estevez JE, Ghazizadeh M, Ryan JG, Kelkar AD (2014) Simulation of hydrogenated boron nitride nanotube's mechanical properties for radiation shielding applications. Int J Chem Sci Eng 8(1):63-67.
[19]. Orca S (2009) Spinning Boron Nitride Nanotubes into Yarn. Published: December 28, 2009 On http://hplusmagazine.com/2009/12/28/spinning-boron-nitride-nanotubes-yarn/