CEOCFO Magazine

ceocfointerviews.com

Issue: May 22, 2017

BORONITE
Extraordinary Materials for a Demanding World

Revolutionary Boron Nitride Nanotube Fiber and Yarn Developer provides Electro-Mechanical, Thermal, Shielding and High Fracture Energy Properties

David Lashmore
Chief Executive Officer & Co-Founder

American Boronite Corporation
www.boronite.com

Contact:
David S. Lashmore
603 276 8487
David.Lashmore@boronite.com

Interview conducted by:
Lynn Fosse, Senior Editor
CEOCFO Magazine

"This material is in principle much stronger and much tougher than carbon nanotube yarn or any of the polymeric fibers like Spectra or Dyneema."- David Lashmore

CEOCFO: Dr. Lashmore, American Boronite is fairly new. What was the vision when you started and what has transpired so far?
Dr. Lashmore: This company was developed initially as a spinout from the University of New Hampshire in Durham, though much of our newest technology is being developed at the company. We aim at mass production of Boron Nitride based yarn or tape. This has never been done before in a format where the Boron Nitride nanotube forms a continuous seamless tape or yarn. The applications are many and range from very high strength, neutron radiation absorption, high-temperature composites and semiconductor properties.

CEOCFO: Would you explain what Boron Nitride is and why we would want to use it?
Dr. Lashmore: Boron Nitride Nanotube (BNNTs) is a material that on an atomic scale might look like chicken wire rolled into a tube, where at every vertex of the chicken wire you have a Boron atom alternating with a Nitrogen Atom. These mesh structures have a tube diameter ranging from about 3 to 50 nanometers, and the length of these tubes are millimeters, so they have a very high aspect ratio. They are similar to a carbon nanotube, which is structurally, and electronically the same. Because the Boron Atoms and nitrogen have the different character the overall properties are very different, from carbon atom based nanotubes. For example, BNNTs are insulators, whereas the carbon nanotube is a conductor or semiconductors. Another is that they are piezoelectric, which means that if you put tension on them they can generate electricity, and conversely, if you apply a voltage you can cause movement. Another really interesting property is you can change their electronic structure by putting an external transverse electric filed to the material. This is true for carbon nanotubes but much more so for Boron Nitride Nanotubes. They apparently do not burn in air at 900 C .

CEOCFO: Is the world aware of what Boron Nitride Nanotubes can do or are we still in an education phase?
Dr. Lashmore: The world, for the most part, is unaware, though there are some groups in the aerospace industry who know about us. Part of the reasons is that the material is not yet available as a tape or yarn in enough quantity to do measurements. Basic research is being done on some forms of this material by itself and in combination with graphene. Our company does not publish.

CEOCFO: What is American Boronite doing today?
Dr. Lashmore: American Boronite is conducting research and development on a small scale to find out the means and mechanisms to scale the production of Boron Nitride Nanotubes and Boron Nitride Tapes onto large volumes. We are looking at the basic science as well as large scale manufacturing of continuous tapes and yarns.

CEOCFO: What are the challenges you are looking at? Why is it difficult to do Boron Nitride Nanotubes in large volumes?
Dr. Lashmore: Even though it is a very similar kind of material to carbon nanotube there turned out to be many issues in the physics of how the chemistry of the building blocks for this material interact that are different and pose challenges. The raw materials to make carbon nanotube are simple organics such as grain alcohol or methanol along with a catalyst, which is usually a small particle of iron. For Boron Nitride the fuels are more complex and they are usually hazardous, however, they also use a similar kind of catalyst. The problem is understanding the fuels and how they interact and breakdown in ways to make the sub-groups that later self-assemble to make the nanotubes, and in turn, self-assemble to make a kind of mesh structure that we form into a yarn or tape.

CEOCFO: Why were you sure that the difference is big enough to make it worthwhile?
Dr. Lashmore: Boron Nitride Nanotube is a game-changing material. It has the capability of being the strongest material every made in terms of a yarn. For composite applications it is really interesting because it conducts heat really well but not electricity. It has may be added to a printed circuit board to carry heat but not affect the components added to the board. It is a dielectric so it can be used to replace Teflon for certain applications that then can make the device lighter. These and other extraordinary properties required the material to be made in a format that industry can use.

CEOCFO: What is involved in figuring it out?
Dr. Lashmore: A strong highly educated and close-knit team made of experts in Chemistry, Materials Science, Physics, Engineering and Finance-Business is essential for conducting this kind of research. There are two basic methods to make these materials. One can start off with a material that has within it the Stoichiometric Boron Nitride composition, so the starting material will contain Boron and Nitrogen in the right proportions. These are introduced into a furnace at high enough temperatures and they will split apart and recombine on a catalyst to template tube growth. Another way is to introduce materials that contain just Boron and Nitrogen separately, then put them together at the right place and at the right time at the clean catalyst surface, so everything comes together at the same time. Therefore, the challenges are to create a catalyst 3 nanometers or so in diameter and create the correct ratio of B and N. We create these catalysts outside of our reaction chamber, but we can also create these within the reaction chamber. The second is to developed in-house a means of making low costs fuels which we now do in-house. This has enabled us to overcome a large cost barrier for these fuels. The process technology involves controlling a number of different temperatures throughout the reaction chamber, as well as the mass transport of the different ingredients and understanding the chemistry at a deep level.

CEOCFO: Are you funded for the research? Are you seeking partnerships or investment?
Dr. Lashmore: Currently our hope is not to take any investors and operate only on contracts and sales but we wil look at potential collaborations. The company is owned by myself and my partner Pavel Bystricky, Ph.D. (CTO) and Ivka Kalus, MBA (CFO) as well as our early hire employees. We have a great deal of interest from industry, as some industries understand the significance of this, so I do not think to generate large amounts of money will be a major problem for us should it be necessary.

CEOCFO: Are you working on educating the industrial world or is that something for the future?
Dr. Lashmore: I normally give two only or three talks a year on a fundamental issue concerning Boron Nitride mostly at Universities. However, I do not think it is time to do a major push for educating industry because we are not in a position to supply samples as yet.

CEOCFO: What did you show at the Defense Innovation Summit?
Dr. Lashmore: We showed a chart of potential applications, which include body armor. This material is in principle much stronger and much tougher than carbon nanotubes or any of the polymeric fibers like Spectra or Dyneema. We showed applications for structural health monitoring, and if we can put a yarn of this material in the element like the windmill blade or the wing of an airplane and measure the voltage we know when and where when that part is strained. Therefore, such as in a windmill, if there is a big storm you would know when to turn the edge of the blade into the wind to reduce the stress. In the case of an airplane, you will know what the history of the airplane stress, so in a bad landing can be measured you can accumulate knowledge of any damage to the structure.

CEOCFO: With so much potential opportunity, how will you decide where to focus or will it be a matter of who approaches you?
Dr. Lashmore: That is also a very good question, as that is always a problem for small companies. What we have done is followed the money. The is at least a rough measure of the commercial value of the material. Obvious applications such

as structural composites are not a high value added but for some other electronic applications, these materials are really important.

CEOCFO: Final thoughts. What should our readers take away about American Boronite?
Dr. Lashmore: We are a company focused on state of art fiber(s). Few institutions outside of NASA to the best of my knowledge, are working on continuous BNNT fiber. It has been tried but found it to be very difficult. However, we have made enough progress to know that we will be successful.