

## Revolutionary Carbon Fiber Composite Material NanoStitch™ Making Airplanes, Cars and Bicycles Lighter, Stronger and Faster



**Brad Berkson**  
President & CEO  
N12 Technologies

**CEOCFO:** *Mr. Berkson, what is the focus in “making the best better” at N12?*

**Mr. Berkson:** The focus is taking the world’s best hi-tech products, from airplanes to automobiles to sporting goods, which are currently made with some of the world’s most innovative and high strength composite materials, and in future improving that performance beyond its current physical capability, by embedding N12 technology into the very same materials systems these OEM’s use, making the best better. So we take the best car and we make it faster. We take the best airplane and make it lighter. We take the best bike frame and make it more durable and stronger.

**CEOCFO:** *How do you decide what to work on? Are you doing this on behalf of clients? Are you developing products and then selling them or looking for people who might use them? What is the business model?*

**Mr. Berkson:** We are essentially aligning with the leading system suppliers in the carbon fiber material business to enter the supply chain; in parallel, we are working directly with OEM’s all over the world to create awareness of our differentiation, in effect a push-pull strategy. So, each of those product categories uses high performance materials like carbon fiber composites and we are partnered with a number of those suppliers to integrate our carbon nanotubes into their products, making them stronger with higher mechanical performance. We work directly with the end users as well, like the prime aerospace players and auto manufacturers, etc., to introduce our material to them so that they can understand the potential it has to change their business and improve their products. It is a dual strategy of going to end users and creating awareness and working with the supply chain partners to provide the material in a very easy to use form factor. The customer does not really change anything. When they make a product, they just use our material, which has already been integrated into their current suppliers’ product.

**CEOCFO:** *What is the change in a product?*

**Mr. Berkson:** Carbon fiber material is pretty much the strongest strength to weight ratio material used today. It is three times stronger than titanium per unit weight. It is extremely strong against pulling forces. Imagine trying to pull on it like a pulling on a rope. The carbon fibers are very resilient and strong in that direction. But while they are extremely strong in one dimension, the other dimensions are not as strong. When you twist, bend, or compress that same material, it is not as strong in the compressive, torsion, and what are called “sheer forces” dimensions. Our material essentially bridges the gap. Carbon fiber composites are made of layers of carbon fiber material, and our nanotubes go perpendicular to those layers, providing essentially a barrier for cracks when a failure starts, and thus improving performance in those twisting, bending, and compressive modes by double-digit percentages, 10-30% depending on the specific test. Furthermore, it significantly improves fatigue life. We have seen improvements of 30 to 100 times stronger material in terms of how long it can last under repeated stresses over time.

**CEOCFO:** *How major of a factor is cost for your clients?*

**Mr. Berkson:** Every major product group that you can imagine, from a cellphone to the fastest high performing aircraft, is concerned about weight. Weight affects fuel costs, mass and all kinds of things that have tradeoffs and consequences as a result. If you look across the spectrum of all those markets I have talked about, price sensitivity varies massively, but N12 is focused on value and scale. Long-term price will not be our determining factor for success in any market. If you are making a high-end, high performance airplane where you can save an amount of weight by removing the layers that are used now to compensate for its weakness in those sheer performance dimensions, the material cost that we are adding is

frankly irrelevant to their cost structure. In fact, we would, at worst, self-liquidate against offsets in other material savings. Spacecraft is an example of that. Material cost for a spacecraft is not the first, second, or third priority. It is really the weight and how much you can get into orbit with a given delivery vehicle. For high-end cars from racecars to super luxury cars like McLaren, this cost is again relatively insignificant to their product. Similarly, in bicycles, at the high end, there are bicycles that are tens of thousands of dollars a unit and the focus is completely on the weight of the bike, which is a key differentiator for the high-end bike market. They too are not as price sensitive. As we grow, to give some scale to this, the carbon fiber materials that we are initially targeting represent about 300 to 500 million square meters of material a year globally. Our targets over the next two or three years are to get into 1-2 million square meters a year, so the penetration does not require us to move down into the base consumer markets for each of these applications. We will stay in the higher-end products that really value the weight reduction, and, as we lower our costs, we will scale and increase penetration down market. So, again, you can think about a consumer golf club and we are working with golf club manufacturers, they are obviously more sensitive to the price than a spacecraft builder is.

**“N12 provides a fundamental technology that will enable a myriad of products to be stronger, better performing, more energy efficient than anything that is in the market. That is what is exciting about this. It is rare that you see a company that has an opportunity to change the world at the scale that N12 does with such a tiny product.” - Brad Berkson**

**CEOCFO: *What is the competitive landscape? Are many companies working on carbon nanotubes? Why a N12 product?***

**Mr. Berkson:** Carbon nanotubes hit fashion 10 or 15 years ago and were discovered about 20 years ago. If you are watching the “buzz” now there is a product called graphene, which is going through a similar “hype-stage” that carbon nanotubes went through 10 years ago. Originally, carbon nanotubes were made in a powder form with a random orientation and dispersed into the resin of the composite materials. In that orientation, they did not work out very well. They tended to agglomerate and clump up. Then they did not disperse, and if they were not dispersed, they really fouled the composite material, leaving more voids and a weaker material, even though they were supposed to have helped. Our technology came out of MIT, out of an aerospace lab funded by a consortium of major aerospace players. The difference in our product was the vertical alignment of the tubes by growing them in that fashion. So rather than having some powder and throwing it into the mix, these were designed specifically to cross the interlaminar region of each of the layers of a composite material. That had a huge impact. If you thought about a comparison, the first generation would be like throwing ball bearings into concrete to try to improve the performance of the concrete. The second is how we do it, which is like putting rebar, a specific geometry of that same material, into the mix. The way it is oriented actually has as big an impact as the strength of the material. The fact that it is oriented in a way that stops the cracks from propagating, and also the way that it is made, the tubes do not agglomerate and detriment the properties like viscosity, voids, and other characteristics of the material. This simplifies our route to market as it means we can add our N12 VACNTs to existing carbon fiber resin systems, making the current systems better and aligning us directly with the primary suppliers to this growing global market. That architecture was developed and patented by MIT, and those are the patents that we have exclusive global rights to. Initially, our customers were those same players who participated in the consortium. N12’s role is to commercialize and scale the technology that has already demonstrated the performance improvements.

**CEOCFO: *Do the companies that you work with understand how your product works? Is it a matter of adaptation for their products or do you have to educate your clients as well?***

**Mr. Berkson:** It is kind of both. Most materials engineers and scientists are convinced that carbon nanotubes should help given their enormous strength properties. A carbon nanotube is incredibly strong. They are the strongest substance known to science in terms of strength to weight; in fact they are 200 times stronger than titanium. Onto the playing field steps N12. A number of our current clients have been through the first phase where expectations for carbon nanotubes generally failed, research budgets seemingly wasted on this in hopes of leveraging the science. That understanding of the basic science of this is still there, and once we get people over the hump of “I have tried this before and it did not work” and actually show them real data, and explain to them what is different about this and why this approach works when the other didn’t, to a client, they all essentially say “I get it.” “I need some of that material. I want to test it to verify that it works.” So they move it to a testing program to make sure it is the real deal. While we often face initial skepticism by clients, once they understand N12’s difference they have, so far, all moved forward.

**CEOCFO: *What is involved in manufacturing?***

**Mr. Berkson:** We manufacture the carbon nanotubes. We have the first industrial scale vertically aligned carbon nanotubes manufactured in the world. That is a technical innovation that, along with our intellectual property, gives us a distinct advantage. We have the ability to continuously grow carbon nanotubes on a sheet, essentially on a tape. What we

do is we grow those nanotubes on that tape and then transfer that material onto a surface of a carbon fiber sheet. So now the sheet has a surface of vertically aligned nanotubes on one side and then, as that is laid up, those nanotubes bridge the interlaminar resin layer. So we are in the vertically aligned carbon nanotube manufacturing business as the key way that we create the value for the client and we are integrated into the supply chain with the various people who make those carbon fiber sheets. Essentially, a customer like a Boeing, for example, would just buy the same base material they have used before. We would have transferred our tubes into that base and they would go through the same process they currently do to cut, build, cure, and machine the parts into its final form.

**CEOCFO: *What are your plans for the funding you received in September? How far will the funding take you?***

**Mr. Berkson:** That funding will be used to build roughly two million square meters a year of capacity. At that point, we would have enough material to penetrate less than 1% of the total pre-preg carbon fiber material market. While that is a fairly minor penetration of the market, for us it would be a sizable amount of product produced. We have targeted to reach those numbers in the next three or four years, and our funding provides capital to reach that point.

**CEOCFO: *What has surprised you so as N12 and NanoStitch™ have developed?***

**Mr. Berkson:** I think the biggest surprise was realizing how similar the process of material qualification is from a golf club to an airplane. You would think there are many more differences between them, but they really have to do same kinds of testing, with the main difference being the level and intensity. By and large, even though these markets sound remarkably different, they are actually quite similar in how they view, test, and validate new materials. That was a little surprising and it is one of the reasons why we are able to attack a relatively broad market. That leads to some interesting contrasts between us as a startup and many others. For example, we are in a facility here in Cambridge with a number of other tech firms, including a biotech firm that is working on one test for one form of cancer. Their team is all focused on that for whatever period of time it takes to get a drug qualified for human use. Contrast that with N12. Everything that moves is our market. It is interesting that you can still do that even though the products are so different because the materials that create all of them are so similar.

**CEOCFO: *Why pay attention to N12 technologies and NanoStitch today? Why is the company so important?***

**Mr. Berkson:** We have had people who have experienced the transition from aluminum to carbon fiber composite materials in aerospace saying that this transition to NanoStitch™ and to the vertically aligned carbon nanotubes is as big a transition as was that transition from aluminum to composites. If you contrast that and scale that to all of its potential, we have a material that would become ubiquitous. As you think about needs for more efficient vehicles, needs for stronger and safer products that use less energy to operate, N12 provides a fundamental technology that will enable a myriad of products to be stronger, better performing, more energy efficient than anything that is in the market. That is what is exciting about this. It is rare that you see a company that has an opportunity to change the world at the scale that N12 does with such a tiny product.

Interview conducted by: Lynn Fosse, Senior Editor, CEOCFO Magazine

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## **N12 Technologies**

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