Nanocomp worked with Lockheed Martin to integrate Miralon into NASA's Juno spacecraft during its development and construction

// PHOTO COURTESY OF NASA //

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Selecting the materials that will be used to build future spacecraft is a critical component of the design process. Multiple considerations are taken into account, such as performance, mass, thermal conductivity, and electrical and mechanical properties. The goal with any payload going on orbit is to reduce its mass (make it weigh as little as possible), without sacrificing reliability or mission objectives.

PROJECT
Carbon Nanotube (CNT) Yarns

MISSION DIRECTORATE
Space Technology

PHASE III SUCCESS
$358K in follow-on Phase III contracts with NASA; additional revenue from commercial customers including Boeing and Lockheed Martin

SNAPSHOT
New Hampshire-based Nanocomp Technologies, Inc. has developed a line of carbon nanotube materials in macro formats that can be used to replace heavier materials for spacecraft, defense platforms, and a host of other commercial applications.

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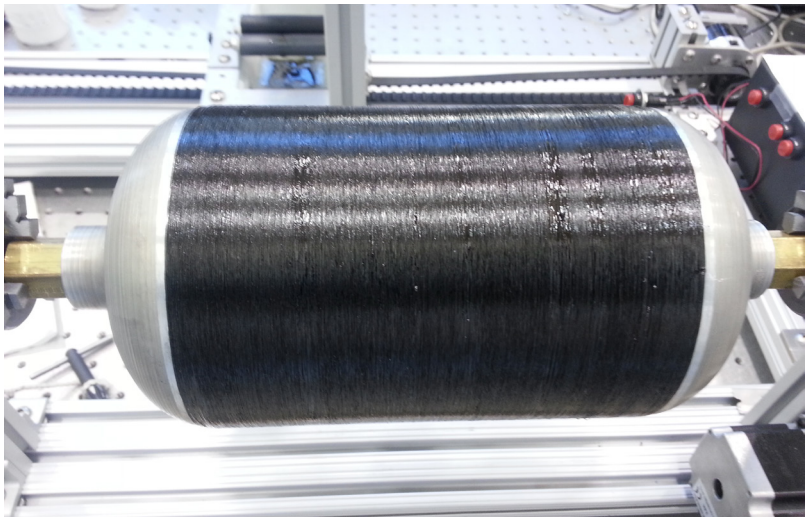
Carbon nanotubes (CNTs) have long been known to exhibit impressive qualities in these areas, providing efficient electrical and thermal conductivity at an ultra low weight. However, larger non-powder forms of CNTs had never been made available until now. Nanocomp Technologies, through support of the Small Business Innovation Research (SBIR) program, is making its Miralon™ CNTs in never-before available macro-formats, and is enabling NASA to construct payloads that weigh less and perform better.

"We manufacture carbon nanotube material in sheet and yarn formats, where industrial partners, people in academia and NASA researchers were curious to assess the mechanical properties for composite applications," recalls John Dorr, VP of Business Development at Nanocomp Technologies. "Once NASA decided they wanted to explore larger quantities, we looked at using the SBIR process to facilitate this goal."

NASA was able to leverage funding originally provided by the Air Force to work with Nanocomp for its specialized objectives through a 2014 Phase III contract. Since CNTs at the nanoscale have a diameter smaller than a strand of hair, the challenge is to scale up without losing their superior properties. NASA's goal was to eventually replace carbon fiber in structural applications with high strength CNT yarn to reduce the weight of composite designs by 30 percent. Nanocomp quickly got to work scaling up a promising R&D prototype into a fully automated yarn post processing line.

"We essentially developed a chemical process to use on the yarn that enhanced the mechanical properties of the materials," says Dorr. "We went from an R&D prototype line to a pilot-scale production



LEFT
Hundreds of meters of Miralon™ yarn used to wrap an aluminum-lined composite overwrapped pressure vessel.

RIGHT
Nanocomp Technologies Miralon™ yarn.

line in just six months that allowed us to more readily manufacture the material and deliver the product to NASA."

Nanocomp's Miralon YM yarn – in which commercialization was accelerated through SBIR and other multi-agency collaborations – is pure carbon nanotube fibers that can be used in a variety of applications to decrease weight and provide enhanced mechanical and electrical performance. Composed of aligned bundles of CNTs that are hundreds of microns in diameter, the fiber is manufactured via chemical vapor deposition into an uncondensed tow that can be spun into the final fiber, plied together to make longer lengths, or stretched to enhance electrical and mechanical properties. Data cables in payloads also present an opportunity for potential reduction in mass which translates to a reduction in weight, as cables made with both Miralon yarn and tape have 70 percent less mass than incumbent materials.

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JOHN DORR
VICE PRESIDENT OF BUSINESS DEVELOPMENT
NANOCOMP TECHNOLOGIES, INC.

Potential commercial applications for Miralon yarn include antennas, high frequency digital/signal and Radio Frequency (RF) cable applications, and embedded electronics. Customers like Boeing and Lockheed Martin are already purchasing from Nanocomp for their specialized needs.

The company has also developed Miralon non-woven CNT sheet and tape products that can be used in a variety of applications including environmental protection, ballistics, and composites. In NASA's Juno spacecraft, Miralon sheets were used to provide protection against electro-static discharge (ESD) as the spacecraft makes its way to Jupiter. The sheets replaced traditional metallic solutions, which are typically bonded to the surface of the composites. Miralon sheets were incorporated as a layer directly onto the composite, making it an integral part of the spacecraft's flight protection system. NASA is building a composite overwrapped pressure vessel that will be launched in the fall of 2016 where Miralon YM yarn is being used for strength reinforcement on the outside of an aluminum tank. Just as Miralon is providing a solution to NASA's needs of lower weight and heightened performance, Nanocomp believes this extends to a variety of sectors and potential applications.

"Right now, based on the results we've seen from this NASA project, we are looking to engage government and commercial partners that make the same type of pressure vessel that NASA will be flying this year, and other high strength composites, using our materials," adds Dorr. "Whether hydrogen or for other bulk natural gas storage or metallic/composite structures that are pressurized for gases, either in the auto or bulk transport sector, to reduce weight without sacrificing the mechanical properties would be important."

The U.S. Department of Defense is interested in Nanocomp's CNT materials for superior strength lightweight body and vehicle armor, lightweight and improved structural components on satellites and lightweight cable shielding for military aircraft. For NASA, Nanocomp envisions its Miralon YM yarn available in a unidirectional tow that will ultimately be used to replace carbon fiber. By continually increasing the throughput and performance of the material and lowering the costs, Nanocomp is hoping CNTs will better compete with carbon fiber and other high performance materials in a wide variety of applications, and give end users throughout many industries the chance to realize the sought after properties of carbon nanotubes.

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