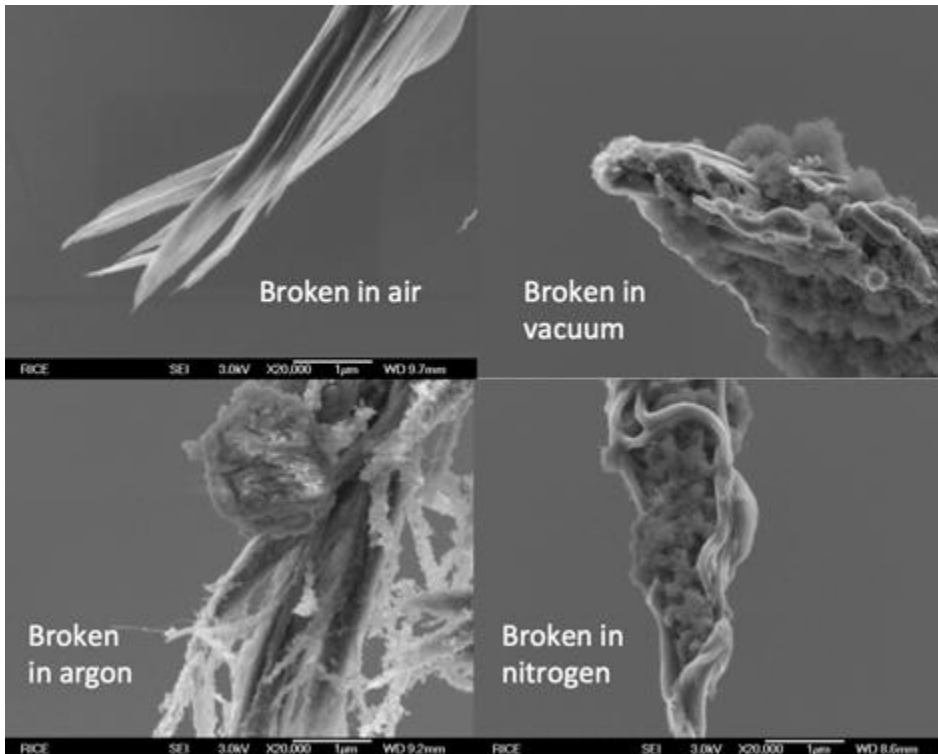


## **Big Fuel Savings in Lightweight Cabling for Aircraft**

Increasingly, the spotlight in aircraft design has been on the development of technology and entertainment systems for greater passenger enjoyment, but what are often forgotten are the cables that support such systems. As these planes become more complex and the demands of passengers more sophisticated, certainly their construction will continue to require cabling, and lots of it. Yet with strict industry standards for safety and reliability, and the need to increase fuel efficiencies, cable design has become a focus of innovation as companies look for ways to cut weight while keeping quality and performance high.

### **Nanotechnology a Key Point of Research for Aircraft Wiring**



Rice University's Carbon Nano-Fiber Tensile Strength Testing - via [The Engineer](#)

One of the most recent innovations in aircraft cabling weight reduction is coming from the world of nanotechnology. Rice University in the US recently invented high-capacity nanotube-based fibers that carry electrical current better than copper cables of the same mass. They discovered that wet-spun carbon nanotube fiber wiring can transmit four times as much current than copper of the same mass, making it ideal

for aircraft manufacturing in terms of power transmission systems. Yet because of their tensile strength,

carbon nanotubes do not have the same problems as aluminum and copper in terms of weight – less is more, as it were.<sup>i</sup>

It's their current carrying capacity (CCC) that makes carbon fibers so amazing. "The outcome is that these fibres have the highest CCC ever reported for any carbon-based fibres," said Junichiro Kono of Rice University's study team. "Copper still has better resistivity by an order of magnitude, but we have the advantage that carbon fibre is light. So if you divide the CCC by the mass, we win."<sup>ii</sup>

These fibers are also more resistant to breakage. In general, electrical cables heat up because of resistance, and when the load exceeds capacity, they become hot and break. Nanotube technology, on the other hand, can withstand much more current, making them stronger and less likely to break down. While copper wiring breaks after 14,000 bends, CNT yard lasts for 2.5 million cycles, making it 2,000 times less likely to fracture.<sup>iii</sup>

As a show of confidence for the use of carbon nanotube technology in the aerospace field, the US Department of Defense recently provided a U\$18.5 million grant to research nanomanufacturing for cable production. The funding went to Nanocomp Technologies, Inc. to supply components such as tape, sheet, carbon nanotube yard, and slurry materials for the development of products for the Department of defense and commercial industries such as aircraft design.<sup>iv</sup>

In particular the company's CText conductors and EMshield tapes are materials that will replace copper in cables to reduce the weight by as much as 70 percent.<sup>v</sup> The pure carbon wires and yarns are comparable to copper in terms of data conductivity, but offer lighter weight, increased strength, and resistance to corrosion. Additionally, their tapes, which can be used for electric and data wires, offer high-performance shielding and effective ground returns.<sup>vi</sup>

### **Insulation and Taping Seeing Development in Aircraft Wiring**

Aside from the advanced technologies such as nanofibers, there have been many developments in the conventional materials used for cabling in aircraft design. For instance, the Star-Quad data cable created by Draka Felica in Sainte-Genevieve, France, recently won an aviation industry prize - DuPont Plunkett Awards in the EMEA Region - for its lightweight properties. By modifying the design with fluoroplastic foam rather than fluoroplastic for insulation, the Star-Quad cable can reduce data wiring weight by 25 percent compared with similar diameter transmission cabling.<sup>vii</sup>

This cabling was developed by the company for Airbus' A350 aircraft for digital data transmission, and is able to handle high transmission rates at a lighter weight without reducing the diameter. The weight

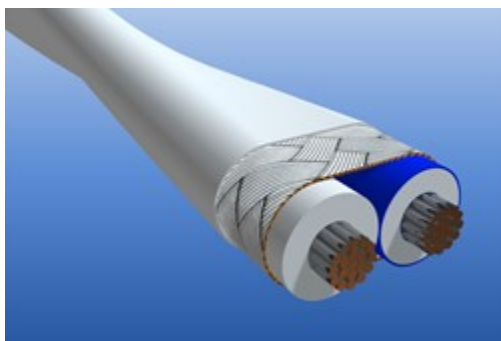
reduction for the A350 is 85 kg for a fuel savings of 510 tonnes and greenhouse gas emissions savings of 1,700 tonnes over its lifetime. There are plans to roll out the same wiring in the A380 as well. <sup>viii</sup>

Nexans is another of the developers of conventional cables and cabling systems for aircraft construction, creating everything from airframe wiring to fire-zone and high temperature cables as well as coaxial databus, quad Ethernet, and optical fiber systems for in-flight entertainment. They recently showcased weight-saving cables that are based on a smooth wrapped-tape insulation design with lightweight aluminum alloy. Their aim in developing these new cables was to address the need for aircraft wiring that is thermally stable while also mechanically proficient. <sup>ix</sup>

Their tape wrap insulation was created to overcome heat problems with high-density wiring. Their tape design uses a high-thermal resistance material that also has better mechanical properties. They also claim that their tape makes their wiring faster to wrap, quicker to install, and easier to handle. Of course, it is also lightweight, making it an ideal choice.

Their smooth cables also offer advantages, most particularly that they are thermally stable with an insulation system that is 30 percent higher than extruded or cross-linked insulated products that are rated for 200°C. Theirs is rated to 260°C making it far more heat resistant, which means they can be installed throughout the aircraft, including locations such as landing gear, wing assemblies, and fuel tanks. They can also be bundled in greater numbers with different wires while maximizing the current that can be pushed through them. <sup>x</sup>

Additionally, the smooth cable speeds the challenges of installation because of the ease with which it is pulled through the airframe structure without snag damage. The specially-designed PTFE surface also helps to resist cuts, tears, and abrasions, thereby reducing installation costs and collateral damage to the



[Gore Shielded Twisted Pair Cables](#)

wires. It can also be marked with UV laser for easy identification. Together, all of these advantages also amount to weight savings of 30 percent compared to other cabling technologies. <sup>xi</sup>

The aluminum cables are also a weight-saver from Nexans, offering a 35 percent reduction overall compared to copper-core cables. Their tape wrapped cables are already in use in three programs: Boeing F-15, Lockheed Martin F-35, and Gulfstream G650 business jet, while their aluminum based cables are in use for several North American and European

airlines. <sup>xii</sup>

Another development in the world of high-density cabling that meets lighter weight requirements is the release of Gore’s shielded twisted pair cables. Constructed with engineered fluoropolymers, these cables are significantly lighter yet provide high signal reliability for the demanding needs of the airline industry. Showcased by W. L. Gore & Associates at the Dubai World Central Airshow in November 2013, these cables are billed as a solution for high-speed data communication over long distances between avionics transmitters and receivers because of their high-speed transmission. This minimizes the needs for additional amplification, which further reduces material requirements.<sup>xiii</sup>

The cables have a smaller diameter and a tight bend radius which results in the ability to use these wires in smaller areas and more densely. These qualities also make the cabling easier to install because of their flexibility to fit into tight spaces to simplify initial routing. The cables are also durable against the extreme elements of flights, able to withstand temperature changes from  $-55^{\circ}\text{C}$  to  $200^{\circ}\text{C}$ .<sup>xiv</sup>

This also gives them less weight, offering fuel savings, with an estimated weight savings of 37 percent compared to ethylene tetrafluoroethylene (ETFE) materials and 50 percent weight savings in comparison to fluorinated ethylene propylene (FEP).<sup>xv</sup>

### **Wiring a Big Target for Weight Savings in Aircraft**

Given that the average 747-400 plane requires 171 miles of wiring, which adds significant weight to these massive machines and increases fuel costs dramatically, there is tremendous potential for fuel and cost savings with lighter weight cabling. As such, this industry is likely to see a lot of development in the years to come. The areas of conductor materials, insulation, and so forth will continue to see research funding as manufacturers and governments alike look to make flying more fuel efficient and cost-effective.



**Maryruth Belsey Priebe**

Maryruth can't help but seek out the keys to environmental sustainability - it's the fire that gets her leaping out of bed every day. With green writing interests that range from sustainable business practices to net-zero building designs, environmental health to cleantech, and green lifestyle choices to social entrepreneurship, Maryruth has been

exploring and writing about earth-matters and ethics for over a decade. You can learn more about Maryruth's work on [JadeCreative.com](http://JadeCreative.com).

## Sources

---

<sup>i</sup> *Carbon nanotube-based cables carry four times the current of copper.* (2014, February 17). Retrieved March 30, 2014, from The Engineer: <http://www.theengineer.co.uk/channels/design-engineering/news/carbon-nanotube-based-cables-carry-four-times-the-current-of-copper/1018031.article>

<sup>ii</sup> *Carbon nanotube-based cables carry four times the current of copper.* (2014, February 17). Retrieved March 30, 2014, from The Engineer: <http://www.theengineer.co.uk/channels/design-engineering/news/carbon-nanotube-based-cables-carry-four-times-the-current-of-copper/1018031.article>

<sup>iii</sup> *Pure carbon wires carry data and electricity, yarns provide strength and stability.* (n.d.). Retrieved March 30, 2014, from Nanocomp: <http://www.nanocomptech.com/conductors-and-yarns>

<sup>iv</sup> *United States Department of Defense Provides \$18.5 Million in New Funding to Expand Nanocomp Technologies' Nanomanufacturing Production Capacity.* (2014, January 15). Retrieved March 30, 2014, from PR Newswire: <http://www.prnewswire.com/news-releases/united-states-department-of-defense-provides-185-million-in-new-funding-to-expand-nanocomp-technologies-nanomanufacturing-production-capacity-240283021.html>

<sup>v</sup> *United States Department of Defense Provides \$18.5 Million in New Funding to Expand Nanocomp Technologies' Nanomanufacturing Production Capacity.* (2014, January 15). Retrieved March 30, 2014, from PR Newswire: <http://www.prnewswire.com/news-releases/united-states-department-of-defense-provides-185-million-in-new-funding-to-expand-nanocomp-technologies-nanomanufacturing-production-capacity-240283021.html>

<sup>vi</sup> *Pure carbon wires carry data and electricity, yarns provide strength and stability.* (n.d.). Retrieved March 30, 2014, from Nanocomp: <http://www.nanocomptech.com/conductors-and-yarns>

<sup>vii</sup> *Ultra-lightweight Star-Quad data cable from Draka Fileca for the aviation industry wins third prize ...* (2013, November 15). Retrieved March 30, 2014, from Innovations Report: [http://backend.innovations-report.com/html/reports/awards\\_funding/ultra\\_lightweight\\_star\\_quad\\_data\\_cable\\_draka\\_fileca\\_222783.html](http://backend.innovations-report.com/html/reports/awards_funding/ultra_lightweight_star_quad_data_cable_draka_fileca_222783.html)

<sup>viii</sup> *Ultra-lightweight Star-Quad data cable from Draka Fileca for the aviation industry wins third prize ...* (2013, November 15). Retrieved March 30, 2014, from Innovations Report: [http://backend.innovations-report.com/html/reports/awards\\_funding/ultra\\_lightweight\\_star\\_quad\\_data\\_cable\\_draka\\_fileca\\_222783.html](http://backend.innovations-report.com/html/reports/awards_funding/ultra_lightweight_star_quad_data_cable_draka_fileca_222783.html)

<sup>ix</sup> *Nexans showcases innovative weight-saving cable solutions developed to improve aircraft performance.* (2013, June 17). Retrieved March 30, 2014, from Nexans: [http://www.nexans.com/eservice/Corporate-en/navigatepub\\_310000\\_-32804/Nexans\\_showcases\\_innovative\\_weight\\_saving\\_cable\\_so.html](http://www.nexans.com/eservice/Corporate-en/navigatepub_310000_-32804/Nexans_showcases_innovative_weight_saving_cable_so.html)

<sup>x</sup> *Nexans showcases innovative weight-saving cable solutions developed to improve aircraft performance.* (2013, June 17). Retrieved March 30, 2014, from Nexans: [http://www.nexans.com/eservice/Corporate-en/navigatepub\\_310000\\_-32804/Nexans\\_showcases\\_innovative\\_weight\\_saving\\_cable\\_so.html](http://www.nexans.com/eservice/Corporate-en/navigatepub_310000_-32804/Nexans_showcases_innovative_weight_saving_cable_so.html)

<sup>xi</sup> *Nexans showcases innovative weight-saving cable solutions developed to improve aircraft performance.* (2013, June 17). Retrieved March 30, 2014, from Nexans: [http://www.nexans.com/eservice/Corporate-en/navigatepub\\_310000\\_-32804/Nexans\\_showcases\\_innovative\\_weight\\_saving\\_cable\\_so.html](http://www.nexans.com/eservice/Corporate-en/navigatepub_310000_-32804/Nexans_showcases_innovative_weight_saving_cable_so.html)

<sup>xii</sup> *Nexans showcases innovative weight-saving cable solutions developed to improve aircraft performance.* (2013, June 17). Retrieved March 30, 2014, from Nexans: [http://www.nexans.com/eservice/Corporate-en/navigatepub\\_310000\\_-32804/Nexans\\_showcases\\_innovative\\_weight\\_saving\\_cable\\_so.html](http://www.nexans.com/eservice/Corporate-en/navigatepub_310000_-32804/Nexans_showcases_innovative_weight_saving_cable_so.html)

<sup>xiii</sup> *New Gore® Shielded Twisted Pair Cables Deliver High-speed Data Transmission in a High-density Lightweight Package.* (2013, November 17). Retrieved March 30, 2014, from PRWeb:

<http://www.prweb.com/releases/2013/11/prweb11339646.htm>

<sup>xiv</sup> *GORE® Shielded Twisted Pair Cables: Reliable signal transmission in high-density, lightweight construction.* (n.d.).

Retrieved March 30, 2014, from Gore:

[http://www.gore.com/en\\_xx/products/cables/highdatarate/aircraft/shielded-twisted-pair-wire-2.html](http://www.gore.com/en_xx/products/cables/highdatarate/aircraft/shielded-twisted-pair-wire-2.html)

<sup>xv</sup> *New Gore® Shielded Twisted Pair Cables Deliver High-speed Data Transmission in a High-density Lightweight Package.* (2013, November 17). Retrieved March 30, 2014, from PRWeb:

<http://www.prweb.com/releases/2013/11/prweb11339646.htm>