

**n-tech Research Article**

## **Future Opportunities for Metamaterials in Aerospace and Defense Markets**



**January 2016**



n-tech Research PO Box 3840 Glen Allen, VA 23058

Phone: 804-938-0030

Email: [info@ntechresearch.com](mailto:info@ntechresearch.com)

## Future Opportunities for Metamaterials in Aerospace and Defense Markets

Aerospace and defense market is often presented as the most vibrant sector of the metamaterials market. Certainly it is where much of the R&D funding has gone, but, nonetheless, n-tech's analysis suggests that not a lot of actual commercial revenues have been generated in this part of the metamaterials market.

1

In fact in 2016 n-tech believes that metamaterials will clock up less than \$45 million in actual sales to the aerospace and defense sector. The big payoff in this area won't come for a few more years, although the indications are that the 2016-2020 will be a takeoff point for metamaterials used in aerospace/defense applications.

### Drivers of Metamaterials Market Growth in Aerospace and Defense

We expect commercial sales of metamaterials-based components and subsystems for aerospace and defense applications to reach around \$250 million by 2020 and then burgeon \$2.3 billion in 2025.

Several factors will contribute to this rapid growth, but as the exhibit below indicates, an important factor is that there appears to be a good fit for metamaterials with the megatrends that are propelling the defense and aerospace sector as a whole. The rise of drones, the need for lightweighting and the inevitable need for improved military communications are all areas where metamaterials can help propel things forward.

**Cutting radar down to size:** As n-tech sees it, an important driver for the use of metamaterials is the ability of metamaterials to expand the use of radar by making it compact and inexpensive enough to be more widely used in antimissile systems, ocean surveillance systems, space surveillance, aircraft anti-collision systems and air-defense systems.

Traditionally, radar instruments are bulky and expensive. However, Echodyne—and potentially other companies in the future—are working on smaller radar devices. But we think that this new generation of radar may take two to three years to impact metamaterials revenues, because while the metamaterials-enabled miniaturized radar systems are a reality now, they have yet to match the performance required for military radar systems.

Indeed, it has been suggested that the initial commercial use of these small systems will be in a new kind of consumer radar for cars and private boats. *Nonetheless, “consumer radar” is largely undiscovered territory with all the inherent risks that this implies, smaller radar systems for traditional markets is a safer bet.*

## Key Trends in Aerospace and Defense and their Implications for Metamaterials

Trend	Examples	Opportunities for Metamaterials	Timeframe
Enhanced communications	Improved antennas are the primary example		Happening now
Radar improvement	Product development at Echodyne and Raytheon	Lighter and more compact radar systems	Happening now, but full commercialization will take some time, because performance must meet high standards of commercial systems
Drones and light aircraft	The use of metamaterials in systems appears to be able to reduce the size and weight of systems		Happening now, but does not seem to be a major focus of work in metamaterials for defense and aerospace applications as a whole. The future of lightweighting will ultimately depend on the cost of fuel
Metamaterials can be marketed as next-generation composites		Composites are all important in the structure of aircraft and military vehicles. Marketing metamaterials as nanocomposites may provide an easier market entry for them into the markets considered in this section	Very limited examples at the present time, but metamaterials may be assumed under the important composite paradigm in aerospace engineering over time
“Invisibility cloaks”	Many R&D trials around the world	Disguising military equipment both in times of war and in espionage activities	For cloaking in the electromagnetic/optical spectrum, time frame is unknown. Acoustical cloaking is a reality now

Source: n-tech Research

**Enhanced military communications:** Radar aside, military forces the world over are always hungry for improved communications. n-tech believes that metamaterials has much to contribute in this regard through their ability to improve the performance of

antennas. Spinoffs from this work will also improve communications for civil aviation and marine communications as well.

As an example of the kind of direction that metamaterials is taking for professional grade antennas, consider the following collaboration between Honeywell Aerospace, Inmarsat and Kymeta, who are working together to design, create and test a new, high-speed Ka-band wireless antenna for business and commercial aircraft customers.

3

This new antenna will bring faster connectivity and a higher-quality broadband service to the aircraft. The planned compact design for this antenna will also allow the antenna to be installed on a wider variety of aircraft, including smaller business aviation aircraft.

The flat-panel design is lighter and – it is claimed -- will reduce weight and drag on the aircraft, in turn reducing fuel and maintenance costs. The goal of this project is also to lower costs, power consumption and the ability to rapidly install antennas. This project is well advanced and our sense of the market is that major aerospace and defense firms will be installing this kind of antenna in quantity, if they are not doing so already.

**Drones, lightweighting and metamaterials:** There is a well-publicized trend towards smaller and lighter aircraft at the present time. This trend is exemplified, of course, by the emergence of drones, but less dramatically by the rise of small jets for business travel and the continued interest in smaller private aircraft.

This trend fits well with the rise of metamaterials. As we have already noted, metamaterials are an enabler to build lighter and more compact sub-systems for aircraft. For this reason, n-tech see lightweighting in the aerospace industry as being an important driver for the metamaterials sector as a whole.

*Perhaps lightweighting technology will begin to lose some of its allure if fuel costs stay low. But for now, at least, we see metamaterials as a useful tool in the lightweighting “armory” for designers of aircraft and military equipment of all kinds.*

*We also think that there will be a familiarity aspect to metamaterials that can be messaged to win the acceptance of such designers. For years now one of the most characteristic aspects of lightweight design of aircraft and military vehicles has been their use of composites. This ties in quite well with the metamaterials theme in that metamaterials are – and are often described as -- a variety of nanocomposite.*

## **Money and Metamaterials**

Finally, another encouraging sign for those planning to sell metamaterials products into the aerospace and defense sectors is that there seems to be plenty of money around for R&D and technology trials. However, government funding for metamaterials appears to be focused in two countries – the United States and China. A few data points to support this assertion.

**United States:** In fiscal 2015, DARPA funding for metamaterials increased by 75 percent. And this year, DARPA is apparently aggressively fund optical metamaterials.

Meanwhile, the U.S. Navy has issued over 60 Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) grants for military metamaterials in the past decade. Other US military sources supporting work on military metamaterials are the U.S. Naval Research Laboratory and the US Air Force.

4

**China:** In China, the government there has been actively funding the military metamaterials. At least 40 research teams have been funded by the Chinese government over the past few years, although the focus here appears to be “invisibility cloaks” for military equipment, an idea that – for obvious reasons – has attracted a lot of media attention, although only limited

Also in the recent past, Xi'an Tianhe Defense Technology, one of China's fastest growing private-sector defense companies, has announced plans to establish a metamaterials defense research and development (R&D) center.

*The bottom line then is that while defense and aerospace may not currently be yielding large commercial revenues for metamaterials, this market is likely to improve quite quickly. In addition, this is segment of the metamaterials market to look to for the most innovative products; aerospace and military applications will be the first place where one might see metamaterials outside of the relatively conventional electromagnetic metamaterials that are being used today.*

**See the n-tech Research report, “[Markets for Metamaterials 2016-2023](#)”**