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Thin carbon sheets for shielding against microwaves

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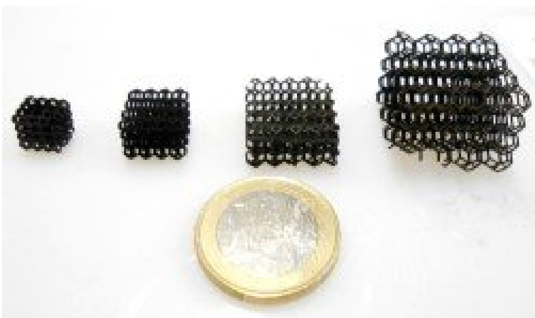

Credit: Alain Celzard

Carbon composites have many useful properties, with new potential uses being discovered all the time. Researchers have developed a thin sheet variety to exploit its electromagnetic properties for microwave shielding.

The unusual properties of high-surface-area carbons provide a tremendous opportunity for scientists to make composites with useful electrical and electromagnetic properties. Carbon composites are particularly useful as low-weight and ultra-thin electromagnetic shielding.

At the same time, ultra-lightweight carbon foams are known to have very high electromagnetic shielding capability due to their cellular structure. They also happen to be cheap, good heat insulators and incredibly strong considering their lightness.

Scientists have begun to investigate the properties of ultra-thin carbonaceous films and their electromagnetic properties. "We expect that they could absorb up to 50 % of the incident microwave power despite the fact that their thickness is only a small fraction of the skin depth," says Dr. Alain Celzard, a researcher leading a team investigating these properties.

Through the EU-funded initiative NAmiceMC, they set out to create a cheap, light and environmentally friendly way to create electromagnetic shielding. Inspired by a unique structure found in moth eyes, the team aimed to eventually create a material that can absorb microwave wavelengths.

NAmiceMC compared the differences in effectiveness for electromagnetic shielding in carbon foams, carbon ultra-thin films and carbon composites. The researchers tested these different materials against a range of microwave frequencies and compared them to a theoretical model of the materials' electromagnetics.

The team conducted a comparative study of electromagnetic shielding effectiveness of different materials and arrangements. "We demonstrated in this project that all types of carbon structure that we investigated could be effective to solve the electromagnetic compatibility problem," Dr. Celzard states.

Useful compounds

Where lightness is required, the team found that both thin carbon films and carbon foams or aerogels are preferable. When good mechanical properties are necessary, they found that the best choice was polymer composites filled with carbon for high-electromagnetic-interference shielding efficiency.

The researchers developed a database with a broad collection of electromagnetic properties and electromagnetic shielding efficiency for each of the types of the materials investigated in the project. They proposed an effective arrangement of the particles in a way that describes the most important features of exfoliated graphite-based composites. The team succeeded in creating a useful and clear methodology for modelling the arrangements without using commercial software.

"The developed methodology provided a better understanding of the physical processes in nanocarbon-based composites," Dr. Celzard notes. The team found that the most suitable shielding materials are those having the highest possible conductivity in the low-frequency range, and which have low thickness.

NAmiceMC had expected to have high absorption that would affect cell and window size of reticulated carbon foams in the material arrangement. However, the team found that the conductivity of the carbon skeleton was so high that these structures were mostly reflective in low-frequency and microwave ranges. The researchers were surprised to find that reticulated carbon foams could be very absorptive in the terahertz range, much higher than the window size predicted.

Moving forward

The NAmiceMC team is actively continuing research in the field of electromagnetic applications of various porous carbon structures. The researchers plan to design new metasurfaces based on a technique developed during the project period, which can transform arbitrary shaped 3-D structures into carbonaceous magnetic materials.

NAmiceMC plans to experimentally prove the concept of an electromagnetic black hole, and to build a prototype of a highly sensitive electromagnetic detector. They have already submitted an MSCA RISE proposal devoted to this activity this year.

Provided by CORDIS

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