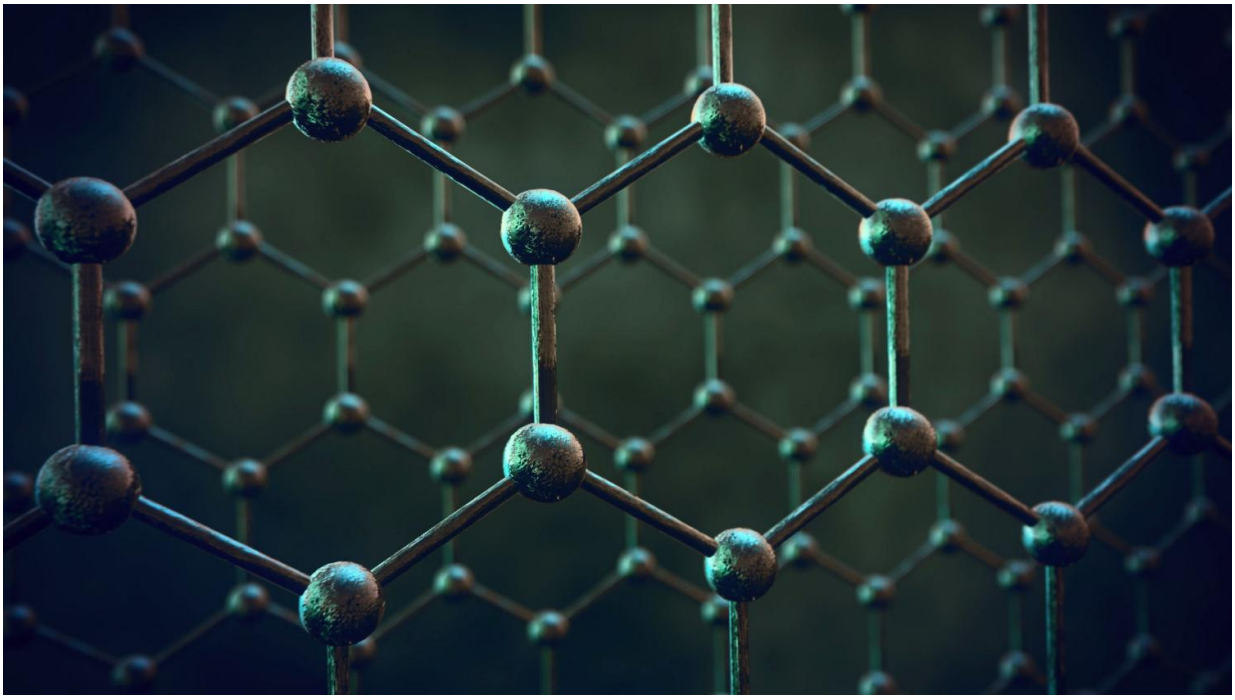
Engineering behind the world's lightest graphene watch

August 29 2018, by Ben Robinson



This visualisation shows layers of graphene used for membranes. Credit: University of Manchester

In January 2017 the world's lightest mechanical chronograph watch was unveiled in Geneva, Switzerland, showcasing innovative composite development by using graphene. Now the research behind the project has been published. The unique precision-engineered watch was a result of collaboration between the University of Manchester, Richard Mille

Watches and McLaren Applied Technologies.

The RM 50-03 watch was made using a unique composite incorporating graphene to manufacture a strong but lightweight new case to house the watch mechanism, which weighed just 40 grams in total, including the strap.

The collaboration was an exercise in engineering excellence, exploring the methods of correctly aligning graphene within a composite to make the most of the two-dimensional materials superlative properties of mechanical stiffness and strength whilst negating the need for the addition of other, weightier materials.

Now, the research behind this unique watch has been published in the journal *Composites Part A: Applied Science and Manufacturing*. The work was primarily carried out by a group of researchers at The University of Manchester's National Graphene Institute.

Project leader Professor Robert Young said, "In this work, through the addition of only a small amount of graphene into the matrix, the mechanical properties of a unidirectionally reinforced carbon fibre composite have been significantly enhanced.

"This could have future impact on precision-engineering industries where strength, stiffness and product weight are key concerns such in as aerospace and automotive."

The small amount of graphene used was added to a carbon fibre composite with the goal of improving stiffness and reducing weight by requiring the use of less overall material. Since graphene has high levels of stiffness and strength, its use as a reinforcement in polymer composites shows huge potential of further enhancing the mechanical properties of composites.

The final results were achieved with only a 2 percent weight fraction of graphene added to the epoxy resin. The resulting composite with graphene and carbon fibre was then analysed by tensile testing and the mechanisms were revealed primarily by using Raman spectroscopy and X-ray CT scans.

The benefits of this research demonstrate a simple method which can be incorporated into existing industrial processes, allowing for engineering industries to benefit from graphene mechanical properties, such as the manufacture of airplane wings or the body work of high-performance cars.

The research group discovered that when comparing with a carbon fibre equivalent specimen, the addition of graphene significantly improved the tensile stiffness and strength. This occurred when the graphene was dispersed through the material and aligned in in the fibre direction.

Dr. Zheling Li, a University of Manchester research associate, said, "This study presents a way of increasing the axial stiffness and strength of composites by simple conventional processing methods, and clarifying the mechanisms that lead to this reinforcement."

Aurèle Vuilleumier, R&D manager at Richard Mille, said, "This project is a perfect example of technology transfer from the university to the product. The partnership with McLaren Applied Technologies allows a broad diffusion of graphene-enhanced composites in the industry. As a tangible result, a world record light and strong watch was available for our customers: the RM 50-03."

Dr. Broderick Coburn, senior mechanical design engineer at McLaren Applied Technologies, said, "The potential of graphene to enhance composites' structural properties has been known and demonstrated at a lab-scale for some time now. This application, although niche, is a great

example of those structural benefits making it through to a prepreg material, and then into an actual product."

More information: Jingwen Chu et al. Realizing the theoretical stiffness of graphene in composites through confinement between carbon fibers, *Composites Part A: Applied Science and Manufacturing* (2018). DOI: 10.1016/j.compositesa.2018.07.032

Provided by University of Manchester