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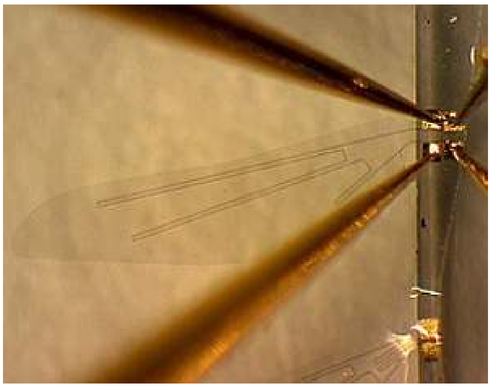
Microactuators: Graphene on dragonfly wings

The integration of graphene into organic films is an effective strategy for creating nimble electrical microactuators.

Electrical microactuators have particularly promising applications in biology, where such devices could replicate the functionalities of muscles. Various materials have been investigated for the construction of these devices, but there remain many issues to be resolved. Inorganic materials such as shape memory alloys and piezoelectric ceramics generally provide good mechanical performance, but can be employed only over a very limited range of temperature and driving voltage. Organic materials like polymers, on the other hand, have wider operating range but suffer from slow response, short life cycles and low efficiency of energy conversion. A research team led by Hyoung Jin Cho from the University of Central Florida in the USA and Jong-Hyun Ahn from Sungkyunkwan University in Korea[1] has now demonstrated a possible solution — integrating graphene into an organic film.



Photograph of a graphene–organic dragonfly wing microactuator

Graphene has the unusual property of contracting as the temperature rises. Cho and Ahn realized that this characteristic could be exploited by coupling graphene films with other organic films with the opposite temperature-dependent change in volume. By varying the temperature locally, the two materials would deform differently, resulting in bending.

Producing such a free-standing graphene-on-organic film, however, required a careful preparation process. Graphene was first grown on a nickel film on a silicon substrate, then patterned into a serpentine by reactive ion etching. An epoxy layer was then formed on top as the body of the device, and finally the silicon and nickel were removed. The device thus produced, in this case a replica of a dragonfly wing (pictured), was placed on a glass support for testing.

Applying a voltage to the graphene serpentine resulted in heating of the entire film and linear displacemen of the device with increasing temperature. Not only was the displacement relatively large, but the response was also quite fast, taking just a tenth of a second to return to its initial position after being displaced by the application of 1 V. The dragonfly wing the team constructed as a practical demonstration of the potential use of such actuators could flap continuously by electrically activating the graphene serpentine.

This demonstration of the monolithic integration of graphene as an active component in microactuators opens the door to various electromechanical and biomimetic applications of graphene–organic hybrid structures.

Reference

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This research highlight has been approved by the author of the original article and all empirical data contained within has been provided by said author.

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