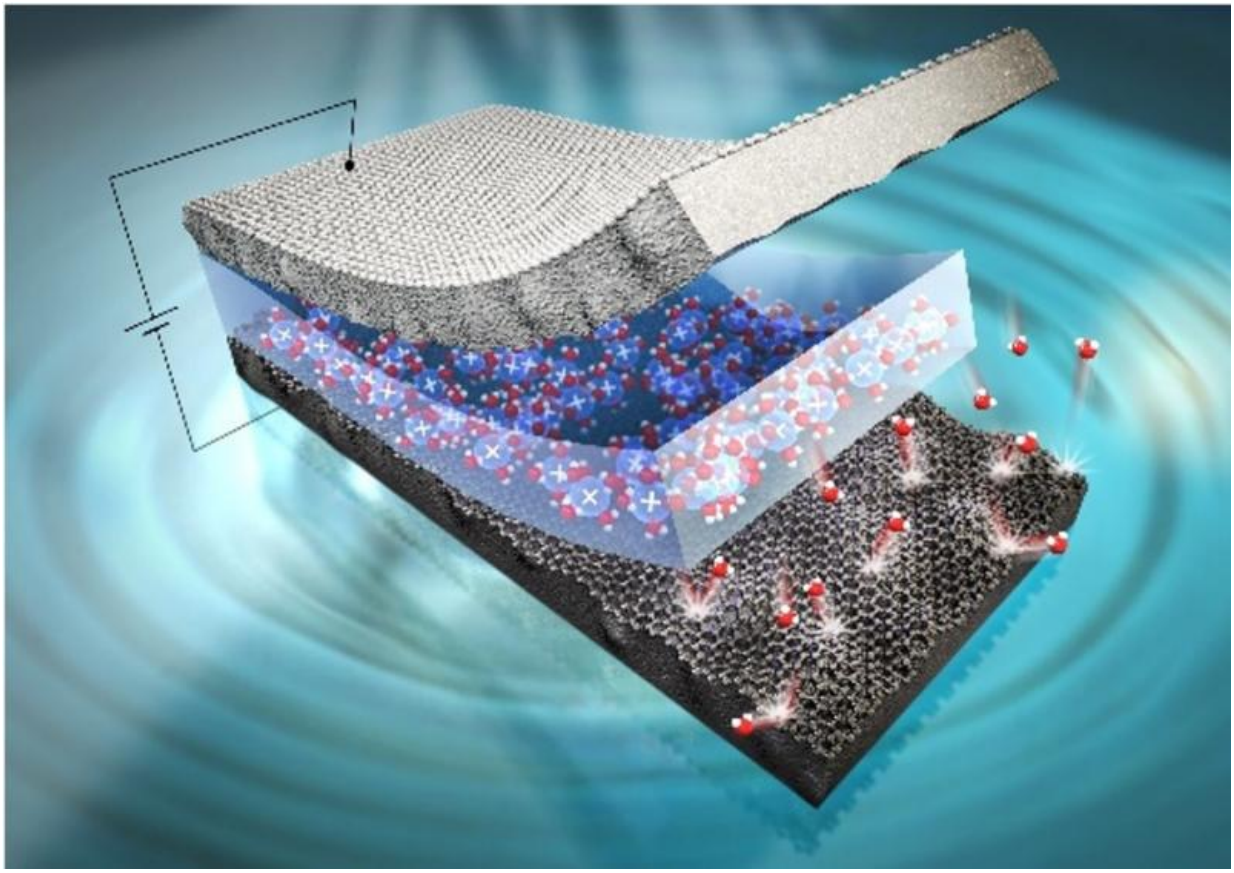
Artificial muscles get graphene boost

May 22 2015



Schematic of the ionic polymer-graphene composite (IPGC) actuator or “motor”. When an electric field is applied, the redistribution of ions causes the structure to bend. Credit: Korea Advanced Institute of Science and Technology

Researchers in South Korea have developed an electrode consisting of a single-atom-thick layer of carbon to help make more durable artificial

muscles.

Ionic polymer metal composites (IPMCs), often referred to as artificial muscles, are electro-active polymer actuators that change in size or shape when stimulated by an electric field. IPMCs have been extensively investigated for their potential use in robotics inspired by nature, such as underwater vehicles propelled by fish-like fins, and in rehabilitation devices for people with disabilities.

An IPMC "motor", or actuator, is formed from a molecular membrane stretched between two metal electrodes. When an electric field is applied to the actuator, the resulting migration and redistribution of ions in the membrane causes the structure to bend. IPMC actuators are known for their low power consumption, as well as their ability to bend under low voltage and to mimic movements that occur naturally in the environment.

They have a major disadvantage, however. Cracks can form on the metal electrodes after a period of exposure to air and electric currents. This can lead to the leakage of ions through the electrodes, resulting in reduced performance.

Improving the durability of IPMC actuators is a major challenge in the field of artificial muscles. Researchers are investigating ways to develop a flexible, cost-effective, highly conductive and crack-free electrode that can be used to construct a durable polymer actuator.

In a paper published in *ACS Nano*, researchers from the Korea Advanced Institute of Science and Technology report the development of a thin-film electrode based on a novel ionic polymer-graphene composite (IPGC). Graphene is a single-atom-thick layer of carbon with exceptional mechanical, electrical and thermal properties. The new electrodes have a smooth outer surface that repels water and doesn't have

apparent cracks, which makes them nearly impermeable to liquids. They also have a rough inner surface, which facilitates the migration of ions within the membrane to stimulate bending.

The new IPGC actuator demonstrates exceptional durability without apparent degradation, even under very high input voltage. It shows promise for use in biomedical devices, "biomimetic" robots that mimic movements occurring in nature, and flexible soft electronics.

The researchers acknowledge that there are still many challenges and more research is needed to realise the full potential of the graphene-based electrodes and their subsequent commercialisation. In 2015, they plan to further enhance the bending performance of the actuators, their ability to store energy and their power.

They also plan to develop a biomimetic robot that can walk and jump on water like a water strider. They will do this by constructing floatable IPGC actuators with a reliable bending performance that can continue for a period of six hours without any apparent change in durability.

Provided by The Korea Advanced Institute of Science and Technology (KAIST)