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Artificial Muscles in Medicine

An artificial muscle with strength and speed equal to that of a human muscle may soon be possible. Polymer gels exhibit abrupt volume changes in response to variations in their external conditions shrinking or swelling up to 1000 times their original volume. Though the promise of an artificial muscle is real, many fundamental physical and engineering questions remain before the extent or limit of these devices is known.

Nanotechnologists have created artificial muscles by spinning carbon nanotubes into yarn that is stronger than steel. The material driving these arms is a little-known one called electroactive polymer that has an unusual property: When stimulated by electricity or chemicals, it moves. It expands and contracts, curls and waves, pushes and pulls. It's also springy, durable, quick, forceful and quiet. Since those properties are shared by human skeletal muscles, electroactive polymers have been dubbed "artificial muscle."

A catalyst-contacting carbon nanotube electrode is used as fuel-cell electrode to convert chemical energy to electrical energy as a super-capacitor electrode to store the electrical energy. It is also used as a muscle electrode to transform the electrical energy to mechanical energy. Then, a fuel-powered charge injection in a carbon nanotube electrode produces the changes that are needed for it to function. This is possible due to a combination of quantum mechanical and electrostatic effects present on the nano scale. A carbon nanotube is a little cylinder of carbon that can be one-thousandth the diameter for a human hair. Further, the individual carbon nanotubes are twisted together until it reminisce some sort of a yarn.

Another version of the artificial muscles, currently the most powerful one, converts the chemical fuel to heat by a catalytic reaction of a mixture of fuel and oxygen in the air. The increase in temperature causes a contraction of a shape memory muscle wire that supports the catalyst.

The patent applications for the muscle is still pending, but there is a diverse application opportunity. They range from robots and morphing air vehicles to dynamic Braille displays and muscles powered by the fuel or air mixture delivered to an engine that are able to regulate this mixture.

In conclusion the fuel-powered muscle can easily be downsized into micro-scales and Nano scales, and arrays of micro-muscles could be used in "smart skins" that improve the performance of marine and aerospace vehicles. By replacing metal catalyst with tethered enzymes, it might eventually be possible to use artificial muscles powered by food-derived fuels that can function in the human body—potentially even human hearts.