Armchair nanoribbons made into spintronic device

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In a development that may revolutionize handheld electronics, flat-panel displays, touch panels, electronic ink, and solar cells, as well as drastically reduce their manufacturing costs, physicists in Iran have created a spintronic device based on "armchair" graphene nanoribbons. Spintronic devices are being pursued by the semiconductor and electronics industries because they promise to be smaller, more versatile, and much faster than today's electronics.

As described in the American Institute of Physics journal Applied Physics Letters, nanoribbons such as these could one day replace indium tin oxide -- an expensive material for which researchers have been searching for suitable substitutes.

Nanoribbons are carbon nanotubes that have been "unzipped" using a room-temperature chemical process to produce ultrathin, flat ribbons of straight-edged sheets of graphene. Finite, narrow strips of graphene are cut out from a two-dimensional sheet of graphene to create the nanoribbons. And depending on how the ribbon is cut out, it results in either an "armchair" or a zigzag edge. An armchair ribbon can be thought of as essentially an unrolled zigzag nanotube.

"We proposed an electronic spin-filter device using nonmagnetic materials. Our system, which is an all-carbon device, passes only one type of spin current," says Alireza Saffarzadeh, an associate professor in the Department of Physics at Payame Noor University. This property is due to the finite-size effect and geometry of the zigzag-edge graphene

nanoribbons, Saffarzadeh explains.

"By applying a gate voltage, the type of spin current can be switched from spin-up to spin-down or vice versa," Saffarzadeh says. "For this reason, the system acts as a spin switch. And these properties are useful in spintronic applications, such as magnetic random access memory."

Saffarzadeh and colleague Roohala Farghadan, a Ph.D. student in Tarbiat Modares University's Department of Physics, found that graphene nanoribbons are good candidates for electronic and spintronic devices due to high carrier mobility, long spin-relaxation times and lengths, and spin-filtering abilities.

More information: The article, "A spin-filter device based on armchair graphene nanoribbons," by A. Saffarazadeh and R. Farghadan appears in the journal Applied Physics Letters. See: link.aip.org/link/applab/v98/i2/p023106/s1

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