Nanoscale freighter hauls its first load

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A nanoscale "monorail" that can creep along a nanotube track has shifted its first load, hauling a gold nugget a distance of 0.5 micrometres. The device could be a useful addition to microscopic construction toolkits that researchers hope will advance computing and other fields.

The new device developed by researchers in Spain, Austria and Switzerland is made from two nanotubes nested like the parts of a telescope.

The central tube is one micrometer long and acts as a rail for the second, smaller, 200-nanometre nanotube. The outer "monorail carriage" is driven by applying current to the inner rail, and can move in both directions along the rail – it can also rotate around it.

In trials, the device was used to transport a ball of gold about 250 nanometres wide along the track for a distance of 500 nanometres (0.5 micrometres). It moves at speeds ranging from 0.1 nanometres per second to 1 micrometre per second. The researchers observed the motion using an atomic force microscope.

Range of movement

"It is the first nano-freighter train," says Andrea Ferrari, an expert in nano-engineering from the University of Cambridge, UK, who was not involved in the research.

Previous nanomotors could only rotate around one axis. The monorail's greater range of movement provides another mechanism for scientists searching for ways to work with nanoscale components as they would with larger objects in a conventional workshop.

The monorail is driven by the heat energy from the electric current flowing through the nanotube, says Adrian Bachtold from the Institut Català de Nanotecnologia in Barcelona, Spain, who worked on the device. When the current is applied a temperature gradient forms, leaving the middle of the rail nanotube at more than 1000 ºC, with either end at just 27 ºC.

Minimal friction

Computer simulations showed that vibrations travel from the hot to the cold areas, carrying the monorail with them. At the moment, the monorail nanotube can only move towards the ends of the rail nanotube from the centre, but the team are working on giving it a reverse gear.

The device was made by zapping carbon-rich material with electricity to grow an initial pair of nested nanotubes. The team ran a large electric current through, making the outer layer come free from the one nested inside. They then burned off most of its length to create the shorter, free-moving monorail carriage.

"The beautiful thing about this device is that the friction between the two nanotubes is very small – the surfaces are almost atomically smooth," says Bachtold.

Ferrari was impressed by the work, saying it advanced previous demonstrations of nanotransport. "However, this is just a first step and significant research and development work is needed to make this a real technology."

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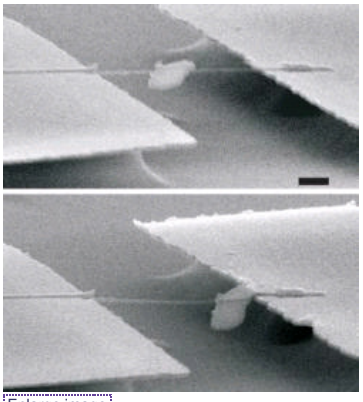

Enlarge image

A nanoscale "monorail" shifts cargo along a track made from a single nanotube, scale bar 300 nm (Image: Science)

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