Bacterial motors could inspire nanotechnology

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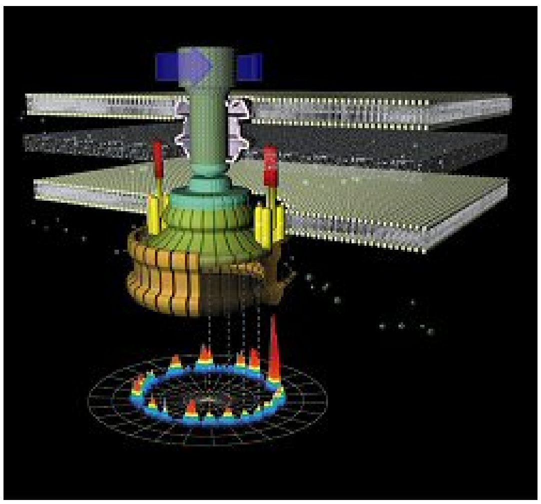

Artist's impression of the bacterial flagellar motor. Credit: Akihiko Ishijima.

An Oxford University physicist sees the future of nanotechnology in the workings of one of Nature's tiniest motors, that which allows some bacteria to swim by rotating slender filaments known as flagella.

'The bacterial flagellar motor is an example of finished bio-nanotechnology, and understanding how it works and assembles is one of the first steps towards making man-made machines on the same tiny scale,' said Dr Richard Berry, a Tutorial Fellow in Physics at Oxford University. 'The smallest man-made rotary motors so far are thousands of times bigger.'

This motor has the same power-to-weight ratio as an internal combustion engine, spins at up to 100,000 rpm and achieves near-perfect efficiency. Yet at only 50 nanometres across, one hundred million would fit onto a full-stop. The only other natural rotary electric motor is in the enzyme ATP-synthase.

Dr Berry is a member of the Rotary Molecular Motors Group in the Oxford Department of Physics. He presented his research at the Biophysical Society's Annual Meeting in Salt Lake City, Utah, on Sunday 19 February.

The physicist and his Japanese colleagues changed the proteins normally found in the motor of E Coli to make it run on sodium instead of hydrogen ions. This allowed them to reduce its speed of rotation by lowering the level of sodium ions present. They also made the actions of the motor more easily detectable by attaching tiny beads to stubs of flagella. Ultimately 26 distinct steps could be observed in each of its revolutions.

'The motor runs on electric current, the flow of hydrogen or sodium ions across the cell membrane, and each step may be caused by one or two sodium ions passing through the motor,' explained Dr Berry.

The tools involved included optical tweezers, which employ light beams to hold and to measure transparent particles, and a high-speed fluorescence microscope which can capture 2500 images per second.

Dr Berry and his colleagues have so far determined the torque-speed relationship of the motor, and that it can have up to twelve independent 'cylinders.'

'Our research will allow us to measure the performance of the motor when we vary things like the driving voltage and number of cylinders, and to understand the physics of the fundamental torque-generating process,' said Dr Berry.

Source: Oxford University