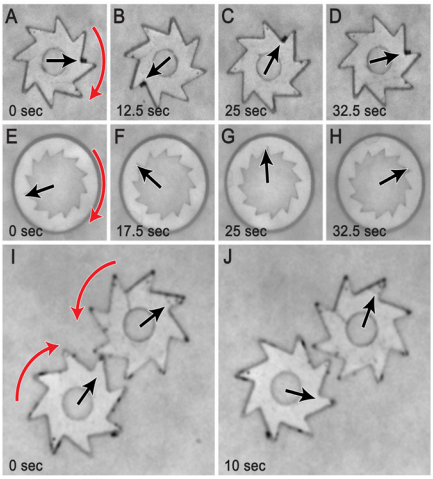
Argonne Scientists Use Bacteria to Power Simple Machines

The symbiosis of biology and hard materials is a major focus of contemporary materials science.

The Challenge

The ability to harness and control the power of bacterial motions is an important requirement for further development of hybrid biomechanical systems driven by microorganisms or synthetic microagents. However, the design of smart, adaptive and self-healing materials presents a very formidable challenge.

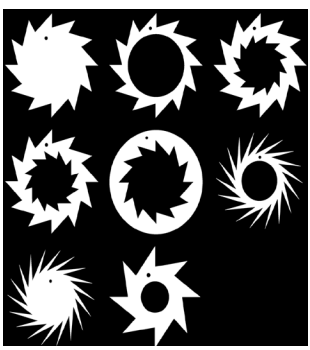


This diagram tracks the movement of gears turned by the Bacillus subtilis *bacteria.*

The Solution

Scientists at Argonne and Northwestern University have discovered that swimming bacteria can turn microgears that are millions times more massive than themselves. The microgears, just 380 microns long with slanted spokes, are placed in the solution along with the common aerobic bacteria *Bacillus subtilis*. Researchers observed that the bacteria appeared to swim at random—but occasionally the organisms collided with the spokes of the gear and began turning it in a definite direction.

A few hundred bacteria work together in order to turn the gear. When multiple gears are placed in the solution with the spokes connected as in a clock, the bacteria will turn both gears in opposite directions, causing the gears to rotate in synchrony—even for long stretches of time.



Silhouettes of several gear designs that could be turned by the bacteria.

The Results

This research helps provide new insights for the design of bio-inspired, dynamic adaptive materials for energy solutions. For example, the new method could lead to materials with novel properties that help improve the efficiency of solar panels and batteries.

"Our discovery demonstrates how microscopic swimming agents, such as bacteria or man-made nanorobots, in combination with hard materials, constitute a 'smart material' which can dynamically alter its microstructures, repair damage or power microdevices," **said Igor Aronson, senior physicist, Argonne National Laboratory.**

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