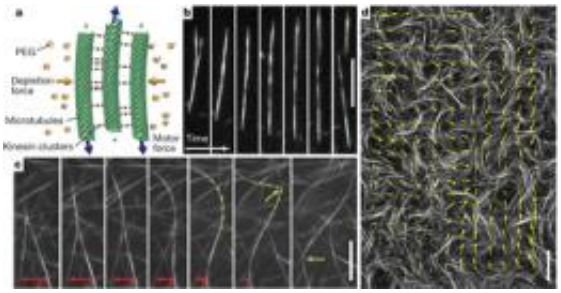
Researchers create gel that displays spontaneous motion (w/ Video)

November 12 2012, by Bob Yirka



Active microtubule networks exhibit internally generated flows. Credit: (c) *Nature* (2012) doi:10.1038/nature11591

(Phys.org)—Physics researchers working at Brandeis University have created a gel that is capable of spontaneous movement. In their paper published in the journal *Nature*, the team describes how they created gel drops by adding protein tubes from cow brains and motor proteins from bacteria to a water solution – adding a polymer to the mix caused spontaneous movement to occur within the solution.

To create drops of the gel, the team mixed protein tubes extracted from cow brains with motor proteins (kinesin molecules) taken from bacteria. Adding adenosine triphosphate (ATP) caused the motor proteins to move along tracks on the outside of the tubes. The result was localized movement. Adding polymers to the mix allowed the motor proteins to span the distance between the individual tubes causing them to slide past

one another. As thousands of the tubes began moving individually around in the liquid solution, the net effect was similar, the researchers report, to cells moving across a slide.

The team reports that the tube movement resulted in the formation of patterns and bundles that grew and eventually fell apart in cyclic fashion and that they could change the movement and formation rate by changing the amount of ATP they added to the mix. Doing so also impacted the duration of the movement. Similarly, they discovered that they could also change the way the tubes moved among themselves by adjusting the number of them originally added when creating the gel. They say also that their micrometer sized drops mimic a living system, one that can be controlled.

In testing the movement in the gel, the researchers noted that the bundle formations demonstrated a self-healing ability which they suggest might lend itself to research involving the creation of more robust liquid crystal display technology. And if the movement can be controlled and fine tuned, other possible uses for the gel might include using them as a drug delivery system or as a means for creating models that mimic swarm behavior. Much more research needs to be done, they note, to discover more about how the gel moves and of course to see if other gels made of other materials can be made to move as well.

More information: Spontaneous motion in hierarchically assembled active matter, *Nature* (2012) doi:10.1038/nature11591

Abstract
With remarkable precision and reproducibility, cells orchestrate the cooperative action of thousands of nanometre-sized molecular motors to carry out mechanical tasks at much larger length scales, such as cell motility, division and replication. Besides their biological importance, such inherently non-equilibrium processes suggest approaches for

developing biomimetic active materials from microscopic components that consume energy to generate continuous motion. Being actively driven, these materials are not constrained by the laws of equilibrium statistical mechanics and can thus exhibit sought-after properties such as autonomous motility, internally generated flows and self-organized beating. Here, starting from extensile microtubule bundles, we hierarchically assemble far-from-equilibrium analogues of conventional polymer gels, liquid crystals and emulsions. At high enough concentration, the microtubules form a percolating active network characterized by internally driven chaotic flows, hydrodynamic instabilities, enhanced transport and fluid mixing. When confined to emulsion droplets, three-dimensional networks spontaneously adsorb onto the droplet surfaces to produce highly active two-dimensional nematic liquid crystals whose streaming flows are controlled by internally generated fractures and self-healing, as well as unbinding and annihilation of oppositely charged disclination defects. The resulting active emulsions exhibit unexpected properties, such as autonomous motility, which are not observed in their passive analogues. Taken together, these observations exemplify how assemblages of animate microscopic objects exhibit collective biomimetic properties that are very different from those found in materials assembled from inanimate building blocks, challenging us to develop a theoretical framework that would allow for a systematic engineering of their far-from-equilibrium material properties.

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