Proteins define the path

NANOBIOMECHANICS

Microtubule filaments carrying micro- or nanosized objects can be propelled over substrates by surface-attached motor proteins. To date, this method has relied upon topographical surface modifications to create predefined paths. Researchers from the Max Planck Institute of Molecular Cell Biology and Genetics, Germany, the Nencki Institute of Experimental Biology, Poland, and the University of Florida have found a far cheaper and easier way of guiding the microtubule transporters. Rather than altering the substrate, they propose depositing patterned motor proteins on planar surfaces [Reuther et al., Nano Lett. (2006) 6, 2177].

The researchers investigated two ways of creating their microtubule guides. In biotemplated stamping, motor domains of kinesin-1 molecules are bound to template microtubules in the absence of adenosine triphosphate (ATP). The resulting complexes are adsorbed onto the planar surface and ATP added to remove the microtubule. This leaves an oriented pattern of molecules on the surface with their motor domains pointing upwards. In biotemplated binding, microtubules are first immobilized on the substrate surface. Motor proteins are bound to the microtubule template in a manner that again leaves the motor domain pointing up. Each motor protein setup guides biotinylated microtubules loaded with streptavidin-coated quantum dots.

"Both approaches can guide microtubule transporters from A to B," says Stefan Diez. "Stamping links the motors to the substrate surface, but the achievable motor densities might be limited. Biotemplated binding allows higher motor densities but a second microtubule binding site is needed in the structure of the motor."

Paula Gould

Smaller sensors may not be more sensitive

MECHANICAL PROPERTIES

A new class of biomechanical sensing device has been based on the notion that the resonant frequency of a cantilever decreases when a mass attaches to its surface. The assumption that smaller sensors ought to be more sensitive has driven the scaling of biosensors into the nano realm. However, new results from Rashid Bashir and colleagues at Purdue University indicate that the response of nanoscale cantilever sensors is much more complex than previously thought [Gupta et al., Proc. Natl. Acad. Sci. USA (2006) 103, 13362]. The classical picture of resonators implies that reducing the area of a cantilever allows the detection of smaller concentrations of biomolecules, while reducing the thickness of the cantilever reduces the resonant frequency to be within the measurement limits. However, a surface layer of receptor molecules is needed to capture specific antigens, which may be of comparable thickness to the nanoscale cantilever and make the mechanical properties very different. The researchers used a laser Doppler vibrometer and fluorescence microscopy to investigate the resonant behavior of Si cantilevers 3-5 µm long, 1.4-1.5 µm wide, and 30 nm thick coated with three different receptors. The measurements show that the resonant frequency of the cantilevers after the attachment of detected proteins can either decrease or increase. For cantilevers with certain geometries and dimensions, protein attachment increases with cantilever size, which leads to an anomalous increase in frequency.

Cordelia Sealy

New angle on sensitive and rapid virus detection

NANOTECHNOLOGY

Researchers from the University of Georgia have devised a new method for detecting viruses rapidly, accurately, and at very low levels [Shanmukh et al., Nano Lett. (2006) doi: 10.1021/n1061666f]. "There is a critical need for a rapid and reliable means of diagnosing infectious diseases such as viruses," says Yiping Zhao. However, current methods of viral detection, which typically rely on antibody-based assays, are cumbersome, time-consuming, expensive, and can have limited sensitivity. New techniques, such as microcantilever sensors, immunosorbtant electron microscopy, and atomic force microscopy are being developed to overcome these limitations, but are currently unable to differentiate between virus species at a reasonable throughput.

Surface-enhanced Raman spectroscopy (SERS) has attracted a good deal of interest because of its remarkable sensitivity down to the single molecule level. However, the technique relies on SERS-active substrates that have proved difficult to fabricate in a robust, simple, and reproducible manner. Recently, the University of Georgia researchers developed a Ag nanorod substrate with an enhancement factor of $10^6$ that is fabricated using oblique angle deposition (OAD). This flexible, easy, and inexpensive technique simply involves positioning the substrate at an angle to the vapor source such that a randomly distributed but aligned nanorod array grows on the surface. Using the Ag nanorod array SERS substrate, the human viruses adenovirus, rhinovirus, and HIV rapidly (in 30-50 s) can be detected from very small sample volumes (<5 µL). Furthermore, the technique is also able to distinguish between different strains of the same virus.

"Compared with the current state-of-the-art in virus detection, the speed, specificity, and relative ease of implementation of the SERS technique make it a highly promising alternative to current viral diagnostic tools and methodologies," says Zhao. The researchers are optimizing the substrate design and fabrication and apply the technique to viruses direct from physiological samples, as well as other chemicals and biological molecules.

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