DNA electrophoresis on nanopatterned surfaces

Current techniques for DNA separation are inadequate for the rapidly growing demand for accurate, versatile, and portable devices for rapid genetic identification. This limitation arises due to two main factors: First, current methods (based on gel or capillary electrophoresis) are tailored to separate DNA in a narrow size range; and second, these methods are limited to shorter fragments of DNA by the fundamental mesh size of the separation medium. We present a new technology that uses nanopatterned surfaces to separate DNA. This technology eliminates the need for disposable separation media (i.e., gels or polymer solutions that are susceptible to degradation and are difficult to load into small devices due to their inherent high viscosity). We demonstrate using molecular dynamics simulations and experiments that this method can simultaneously separate a broad band of DNA ranging from a few hundred base pairs (bp) through genomic size without a loss in resolution. The image below shows results from a MD simulation that tracks the dynamics of DNA on a nanopatterned surface. Chains of different length see the pattern at different scales and this results in separation. Experimental results on similar patterned surfaces also show separation of chromosomal size DNA fragments.

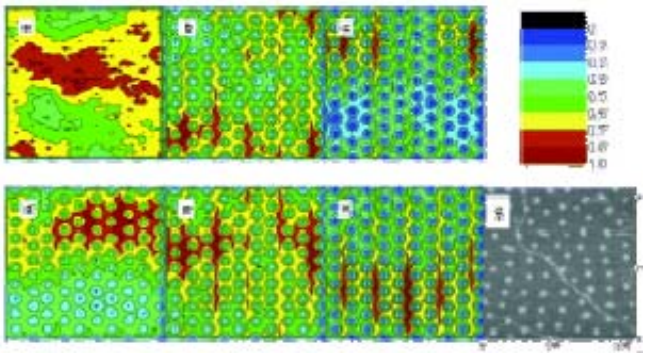


Figure 1: Normalized time averaged segment density per site from the MD simulation. The density per site is calculated by counting the number of times that a site on the surface is visited by a DNA segment and is normalized by dividing by the maximum site density for each simulation. The color bar represents the normalized densities from the maximum value of 1 (red) to the minimum value of 0 (black). Snapshots (ac) are for a chain of N = 60 segments, and snapshots (d-f) are for a chain of N = 120 segments. In a and d, the bare wall interaction is $_{s}$ = 2.25, in b and e the bare wall DNA interaction is $_{s}$ = 2.5, and in c and f the bare wall DNA interaction is $_{s}$ = 3.0. In all cases the patch-DNA interaction is $_{sp}$ = 2.0, thus the bare wall is more attractive than the patch. (g) SPM image in air of a -DNA chain adsorbed from buffer solution onto the nano patterened surface described

Homeland Security Facial Recognition System:

Developed by E. Guan, Ph.D. candidate and Sara Sokolov, High School Research Scholar.

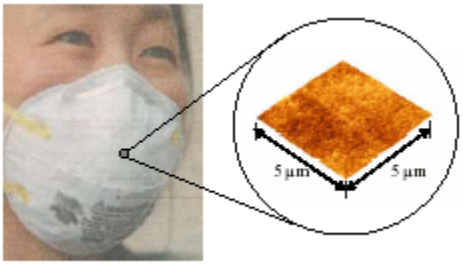
A high-speed camera and strong zoom lens would allow smile maps to be produced without suspects knowing they were being tracked.

MAPPING THE muscles that shape smiles could lead to better face recognition systems, a team of physicists has suggested. E Guan and colleagues at Stony Brook University, New York, say current techniques are easy to evade. Computers can, in principle, match two images of the same person by comparing the pictures pixel by pixel, or by calculating the distances between major features such as the eyes and mouth. But criminals can avoid detection simply by wearing make-up or dark glasses. The Stony Brook system, which was unveiled recently at the American Physical Society meeting in Montreal, relies on probing the characteristic pattern of muscles beneath the skin of the face. Guan takes two snaps of a person in quick succession, asking subjects to smile for the camera. He then uses a computer to analyze how the skin around the subject's mouth moves between the two images. The software does this by tracking changes in the position of tiny wrinkles in the skin, each just a fraction of a millimeter wide. The data is used to produce an image of the face overlaid with tiny arrows that indicate how different areas of skin move during a smile. This movement is controlled by the pattern of muscles under the skin, and is not affected by the presence of make-up or the size of the subject's smile. The system is sensitive enough to produce such a map from muscle twitches even when people try to keep their expression unchanged. The team thinks each person's map may be unique. Guan suggests the system could be deployed at airports, if it passes further tests, to help search for known criminals. He says a high-speed camera and strong zoom lens would allow smile maps to be produced without suspects knowing they were being tracked. The technology may also have medical applications. Guan says that some nerve disorders cause distinctive asymmetries in the movement of facial muscles. Doctors might be able to make an early diagnosis of such conditions by studying facial maps.

Jim Giles
Nature News Service

New "green" polymer thin film processing using supercritical fluids

We found a new state of supercritical carbon dioxide (scCO2) where "long-range density inhomogeneities" cause it to have unusual properties when in contact with polymer interfaces. We have found that exposing polymers to scCO2 in this regime can produce low density films with nanoscale porosity. These films have many industrial applications that we are just beginning to exploit. For example, we have found that this process can be used to produce membranes which are selectively porous to small molecule gases, such as CO2, nitrogen and oxygen, while being impervious to large molecule gases or particulates. This membrane then becomes ideal for incorporation into protective gas mask, which do not inhibit normal respiration while protecting the user against more complex toxic gases, viruses or bacterial. Furthermore, the low-density polymers also have applications as new materials for consumer electronics, polymer metallization, and a new class of plastics with super-impact resistance and flexible simultaneously. CO2 is environmentally benign and hence this new "solvent" may eventually replace organic solvents currently used in even more routine applications.



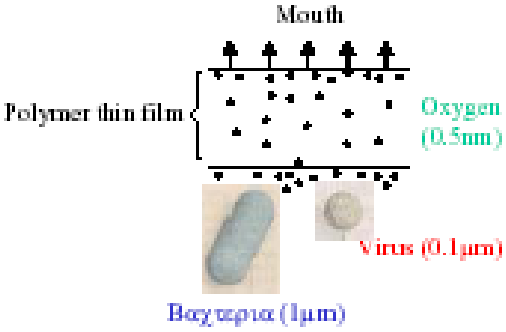


Figure 2: Nanometer scale porosity, which is introduced by exposure to $scCO_2$, selectively permits a large flow of small molecule gases, while completely blocking out larger gases or particulates.