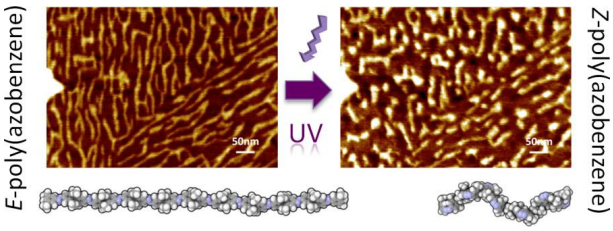
Light-induced movements of single macromolecules on a modified graphite surface

A current challenge to be addressed in nanotechnology is the ability to precisely control the motion of single molecules on an atomically well-defined surface, with the aim of developing "machines" able to perform actual work at the smallest scale. A common strategy consists in creating compounds such that external energy—either chemical fuels or physical stimuli—is converted into movement through concerted conformational changes. Physical stimuli like electrons or photons are particularly beneficial, as they offer a non-invasive, clean way of addressing molecules with very high spatial precision. Several works have already been reported on the electro- or photo-induced motion of relatively small molecules, which were typically observed with very-high resolution microscopes, such as scanning tunneling or atomic force microscopes (STM and AFM). These examples include small molecules resembling wheels, pinions, or even cars.

Although the level of complexity already reached with small molecules is quite impressive, longer molecules, such as polymers, are more promising for obtaining mechanical movements over larger distances.

Now, writing in ACS Nano, David Bléger, Jürgen P. Rabe, and co-workers Chien-Li Lee, Tobias Liebig and Stefan Hecht, from IRIS Adlershof and the Departments of Physics and Chemistry of the Humboldt-Universität zu Berlin, have realized a system, in which single polymers can be reversibly contracted and stretched on a modified graphite surface by using two different types of light (UV and blue).



The macromolecules, visualized by AFM, were found to contract with large amplitudes, and sometimes move across the surface, resembling a "crawling" movement. The key to achieving these motions was first, to design polymers in which dramatic contractions could be reversibly induced by light, and second, to modify the surface for at the same time orienting the linear macromolecules, isolating them from each other, and decoupling them from the surface. The next steps will consist in finding ways to control the directionality of the movements, thus opening up new possibilities for the development of optomechanical nanosystems.

Light-Induced Contraction and Extension of Single Macromolecules on a Modified Graphite Surface
C.-L. Lee, T. Liebig, S. Hecht, D. Bléger, and J.P. Rabe
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