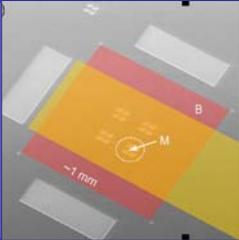


# UWAMIC NEWSLETTER

Summer 2008, Volume 2, Issue 2



## A Message from the Directors

### Welcome to the Summer 2008 UWAMIC Newsletter!

Our consortium continues to grow as we add Rayovac/Remington to our membership. As always, we have several potential member companies looking at the benefits of joining. We appreciate you sharing this newsletter and our website information with colleagues you think may be interested in knowing more about our program.

Since we haven't had a lot of response, I would like to repeat my request that you visit the website [www.uwamic.wisc.edu](http://www.uwamic.wisc.edu) and register for member privileges. The site has new features and frequent updates to the new NEWS section on the main page. It is also important that you login in (create your own account) so we can set flags that allow you to have access to the members only sections, including the student resume section. More changes are on their way and we plan to make the site a useful tool for you to stay current with projects and information about our students, plus archives of past meetings and research publications.

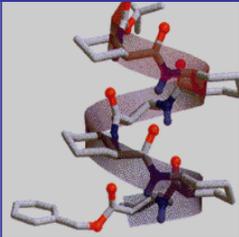
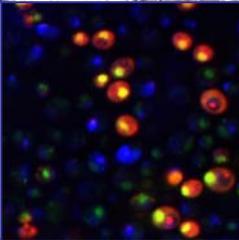
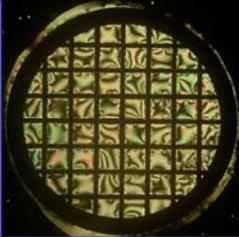
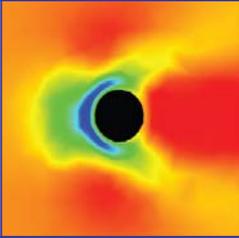
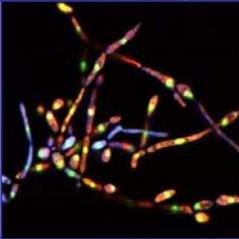
Katie DeBruin remains the primary contact for the website (gathering data, updating the sites), as well as making arrangements and coordinating information for UWAMIC events (annual meetings, membership renewal, etc.). Katie's phone number is (608) 262-0112, her email is [kedebruin@wisc.edu](mailto:kedebruin@wisc.edu), and she is located in 3033 Engineering Hall. Please contact her or me for help of any kind.

Please mark your calendars! This year's Annual Meeting will be held Tuesday, October 7<sup>th</sup> and Wednesday, October 8<sup>th</sup> in Engineering Hall. A preliminary agenda is included with this newsletter, and more details will follow in September, including your invitation.

We hope you enjoy this issue of the newsletter, and, as always, we welcome your feedback as to how we can improve your consortium and the newsletter. Feel free to contact me or Katie with your input or questions.

Regards,

Co-Director, Development



## What's New in the UWAMIC?

### Synchronized Swimming: Collections of Microorganisms Make Their Own Waves

Some microorganisms prefer the breaststroke while swimming. Others move along by essentially twisting their tail. How populations of bacteria and other microorganisms swim is more than just a matter of style, according to **Mike Graham**, University of Wisconsin-Madison Harvey D. Spangler Professor of Chemical and Biological Engineering. Studies of how microorganisms move through and diffuse liquid could enable scientists to develop artificial swimmers, enhance fluid flow in microfluidic devices, or better understand how microorganisms sample their environment. Graham and fellow researchers Patrick Underhill and Juan Hernandez-Ortiz created a computer model that analyzes how populations of up to 100,000 model bacteria swim. Their results, published in the June 20 issue of Physical Review Letters, indicate that the particular style of swimming leads to different large-scale fluid motions and mixing.

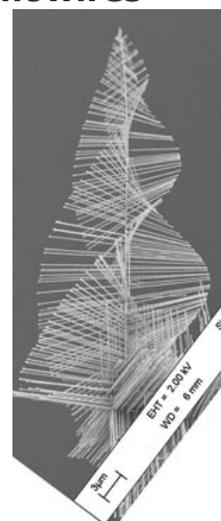
<http://www.news.wisc.edu/15346>



### Spiraling Nanotrees Offer New Twist on Growth of Nanowires

Since scientists first learned to make nanowires, the tiny wires just a few millionths of a centimeter thick have taken many forms, including nanobelts, nanocoils and nanoflowers. But when UW-Madison chemistry professor **Song Jin** and graduate student Matthew Bierman accidentally made some pine tree shapes one day — complete with tall trunks and branches that tapered in length as they spiraled upward — they knew they'd stumbled upon something peculiar. "At the beginning we saw just a couple of trees, and we said, 'What the heck is going on here?'" recalls Jin. "They were so curious." Writing in the May 1 edition of Science Express, Jin and his team reveal just how curious the nanotrees truly are. In fact, they're evidence of an entirely different way of growing nanowires, one that promises to give scientists a powerful means to create new and better nanomaterials for all sorts of applications, including high-performance integrated circuits, biosensors, solar cells, LEDs and lasers.

<http://www.news.wisc.edu/15165>



### Designing a New Catalyst for Cleaner Fuel

As the price at the pump continue to soar, our budget for summer frolicking shrinks. People are choosing either to vacation closer to home or forgo them altogether because of high gas prices. We are all feeling the pinch, and we dream of a gasoline independent world. Will it ever come? Well, it might soon become a reality through research here at UW-Madison. Using hydrogen as fuel is the basis of fuel-cell technology, and though the average Joe probably can't afford to use it to power his car quite yet, that goal's getting closer. UW-Madison professor **Manos Mavrikakis** of the chemical and biological engineering department, along with biochemistry professor Bryan Eichhorn from the University of Maryland, are doing their part by designing more efficient nanoparticle catalysts; the details appeared in the April issue of Nature Materials. This new catalyst is designed for a purer hydrogen fuel, and its properties may make production of this fuel less expensive.

<http://www.dailycardinal.com/article/3098>



## UWAMIC in the News

### Studies of Cell Traits Nets Big Award for UW-Madison Researcher

University of Wisconsin-Madison biochemist **Doug Weibel** may not be able to bend or shape cells any way he wants to — yet. However, Weibel's efforts to uncover the molecular choreography within the cell that governs their physical, chemical and physiological attributes — including shape, behavior and development — have earned the young scientist a prestigious Searle Scholar Award. The \$300,000 award over three years was last conferred on a UW-Madison faculty member in 1997 when pharmacy professor Ben Shen was recognized. The award will support Weibel's exploration of some of the fundamental mysteries of bacterial cells, work that promises to make them more amenable for study and manipulation in the interest of such things as the development of biofuels and new antibiotics.

<http://www.news.wisc.edu/15344>



### Paul Nealey Featured in the May 2008 Issue of APS News

**Paul Nealey** was featured in an article entitled "Macromolecular Self-Assembly a Promising Alternative to Photolithography".

An excerpt:

"Paul Nealey and his colleagues at the University of Wisconsin are investigating techniques to integrate self-assembling block-copolymers into the lithographic process, with the goal of achieving sub-15 nanometer resolution while retaining such essential lithographic benefits as pattern perfection and high-volume manufacturing."

(Full article available online to members.)

<http://www.aps.org/publications/apsnews/>



### Time Magazine Names James Thomson one of "World's Most Influential People"

Stem cell scientist **James Thomson** has been named one of Time magazine's "World's Most Influential People," with Shinya Yamanaka of Kyoto University. Last year, they each discovered a way to give human skin cells many of the characteristics of embryonic stem cells, an advance that avoids the destruction of embryos.

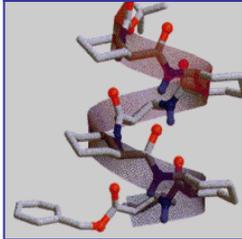
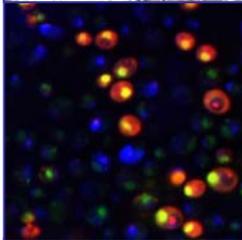
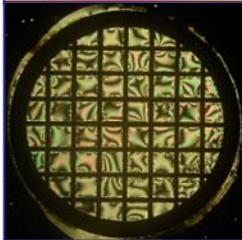
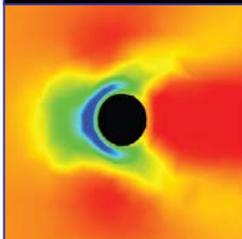
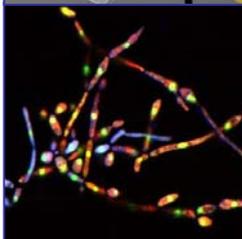
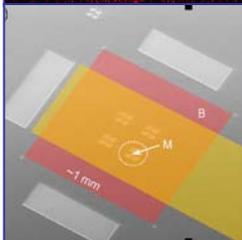
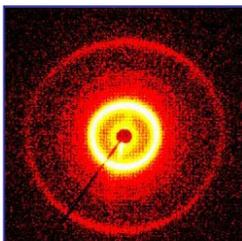
An excerpt:

"Shinya Yamanaka, 45, working in Japan's Kyoto University with mouse cells, made the iPS breakthrough. He screened 24 candidate proteins before finding four that were able to reprogram adult cells, reverting them to their embryonic state. He and others then showed that these factors are also effective in human cells. Developmental biologist James Thomson, 49, of the University of Wisconsin was the first to identify a slightly different group of factors that do the same.

One day iPS cells may be used to replace cells damaged or lost in disease, but much remains to be learned before such therapy would be appropriate. As a step along the way, iPS cells from patients with an inherited disease will offer opportunities to study illnesses such as ALS and Parkinson's and psychological ailments, as scientists program the cells back to their embryonic state and watch them mature in the lab. In the process, they may pinpoint the breakdowns that lead to the disease. The precise mechanism that led to Yamanaka's and Thomson's achievement last year is not yet understood, but the potential of that achievement is; it is a potential that could be unlimited."

[http://www.time.com/time/specials/2007/article/0,28804,1733748\\_1733754\\_1736238,00.html](http://www.time.com/time/specials/2007/article/0,28804,1733748_1733754_1736238,00.html)

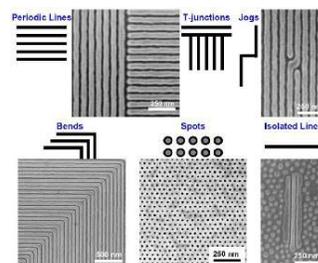
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## Research Highlights

### Directed Self Assembly of Block Copolymers for Nanolithography: Fabrication of Isolated Features and Essential Integrated Surface Geometries

Researchers at the Nanoscale Science and Engineering Center at the University of Wisconsin - Madison have pioneered a pathway to use self-assembling materials for nanomanufacturing. Self-assembling materials are attractive for the fabrication of integrated circuits of computer chips because they may be able to allow fabrication at ever decreasing feature dimensions, resulting in faster and more

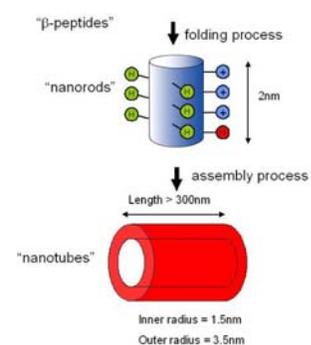


powerful computers, at reduced cost. Block copolymers, the materials of choice here, for example, spontaneously form features with dimensions as small as 10 nm, but the perfection of assembly and range of features shapes or patterns that can be created typically preclude the use of the materials in high-value-added manufacturing processes such as nanoscale lithography.

<http://nsec.wisc.edu/NS--Nugget.php?ID=37>

### Hierarchical Assembly of Organic Nanotubes

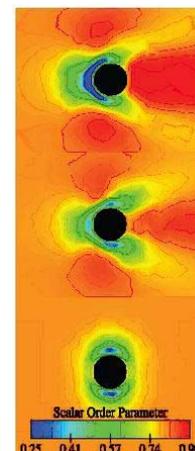
The NSF supported Nanoscale Science and Engineering Center (NSEC) at the University of Wisconsin - Madison has discovered a new way to create organic nanotubes. These are hollow tubes with inner diameters of a few nanometers, and lengths that extend over hundreds to thousands of nanometers. Although various forms of carbon as well as inorganic materials are known to form nanotubes, the special characteristic of the nanotubes formed by the Wisconsin NSEC is that they are assembled from organic nanorods. These nanorods, which are formed by the precise folding of protein-mimetic materials called  $\beta$ -peptides, carry exact chemical patterns on their surfaces. The precision of the chemical patterns is unprecedented for nanomaterials, and the assembly of these nanorods into nanotubes provides a general and facile means to control the functionality of the nanotubes.



<http://nsec.wisc.edu/NS--Nugget.php?ID=41>

### Nanoparticle Defect Control in Nanoparticles in Liquid Crystals

When a nanoscale particle is suspended in a highly ordered liquid crystalline material, the interactions between the particle and the liquid crystal give rise to a small region of low order around the particle. This region adopts the shape of a ring, and is often referred to as a Saturn ring. Computer simulations by researchers at the UW NSEC have revealed that the shape and position of that Saturn ring can be manipulated by simple flow. Depending on whether the particle is soft or hard, the ring will move upstream or downstream from the particle. Particles surrounded by defects exhibit a large propensity to aggregate; the nature of those aggregates is extremely sensitive to the types of defects and their position around the particles. The results by the UW team therefore suggest that the aggregation of nanoparticles in liquid crystals can be manipulated through the judicious application of external fields, including flows.



<http://nsec.wisc.edu/NS--Nugget.php?ID=39>

## Instrumentation News

### Materials Science Center Aberration corrected analytical STEM

The new Titan STEM has arrived and excitement builds as the lab room is being rebuilt to house the instrument. Installation should occur by the end of the year, a bit behind schedule. To remind you this machine will be unique in the upper Midwest and will: (i) enable significant new advances in research in nanomaterials, nanobiology, and energy and the environment, (ii) and enhance training of future scientists, engineers, and EM technicians with new material on STEM.

The instrument is equipped with full analytical attachments and the capabilities added by the STEM system will be:

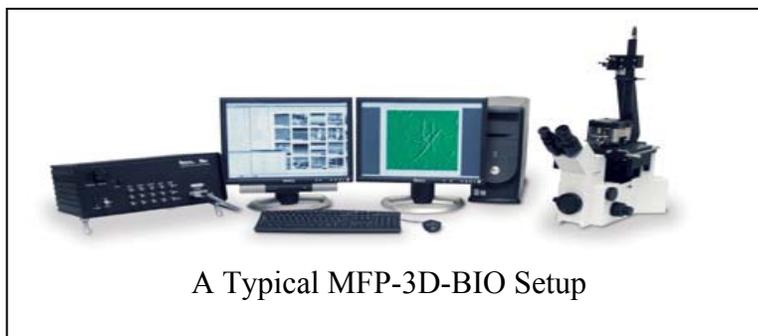
- **Imaging:** High-angle annular dark-field (HAADF) "Z-contrast" STEM; low-angle dark-field and bright-field (BF) STEM imaging; simultaneous acquisition of any two imaging signals.
- **Microanalysis:** Electron energy-loss spectroscopy (EELS) at 0.8 eV energy resolution and 2 Å spatial resolution; energy-dispersive x-ray spectroscopy (EDS) at 130 eV energy resolution and <5 Å spatial resolution; simultaneous EELS and EDS spectrum imaging.
- **Nanodiffraction:** Systematic acquisition of electron nanodiffraction patterns from many positions in registry with a STEM image using coherent probes 2 to 50 Å in diameter.
- **Remote operation:** All the STEM (and TEM) capabilities will be operable via the Internet.



FEI Titan STEM

### Soft Materials Laboratory

This laboratory came on-line in late 2007 and is a completely new and substantial initiative which reflects the theme of polymers and soft materials that runs throughout the majority of the NSEC thrust and seed research programs. We have just placed an order for a unique instrument for imaging and testing the mechanical properties of soft materials, including individual cells and cell components. The instrument will combine an inverted fluorescent optical microscope with an integrated AFM from Asylum Research. The MFP-3D-BIO sets the industry standard for integration of optical microscopy and AFM. Locate your sample features using brightfield, Zernike [phase contrast](#), or [fluorescence](#), then zoom into the nanometer scale with an AFM scan. AFM can be combined with such powerful optical microscopy techniques as confocal, FRET, FRAP, and TIRF, including the capability to synchronize with [confocal](#) measurements.



A Typical MFP-3D-BIO Setup

## Recent Publications

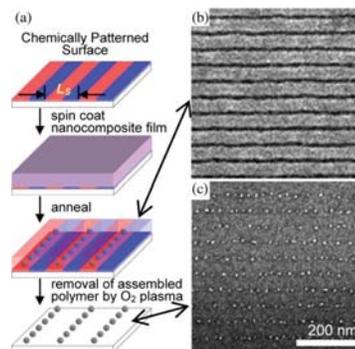
### Hierarchical Assembly of Nanoparticle Superstructures from Block Copolymer-Nanoparticle Composites

H. Kang, F. A. Detcheverry, A. N. Mangham, M. P. Stoykovich, K. C. Daoulas, R. J. Hamers, M. Muller, J. J. de Pablo and P. F. Nealey

*Physical Review Letters* **100**, 148303 (2008)

#### Abstract:

We investigate the assembly of block copolymer-nanoparticle composite films on chemically nanopatterned substrates and present fully three-dimensional simulations of a coarse grain model for these hybrid systems. The location and distribution of nanoparticles within the ordered block copolymer domains depends on the thermodynamic state of the composite in equilibrium with the surface. Hierarchical assembly of nanoparticles enables applications in which the ability to precisely control their locations within periodic and nonregular geometry patterns and arrays is required.



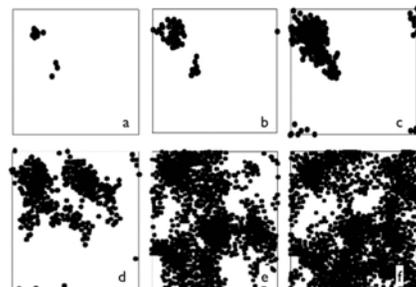
### Molecular Plasticity of Polymeric Glasses in the Elastic Regime

G. Papakonstantopoulos, R. A. Riggleman, J. L. Barat and J. J. de Pablo

*Physical Review E* **77**, 41502 (2008)

#### Abstract:

We examine the plastic deformation of a model polymeric glass under tension. Local plastic events are found at extremely small strains, well below the yielding point, in a regime where the material is traditionally described as perfectly elastic. A distinct relationship is identified between these irreversible displacements (plastic events), the amplitude of segmental motion, local structure, and local elastic moduli. By examining the motion during the deformation of individual sites, we arrive at a mechanistic explanation for how these events arise.



It is shown that, upon deformation, polymer sites that exhibit relatively small but positive elastic moduli are prone to failure. Such sites are also found to exhibit a large vibration amplitude, as indicated by their respective Debye-Waller factors. Sites that fail first tend to have a higher degree of nonsphericity than the rest of the material. We also find the collective occurrence of local plastic events where percolation or concerted action leads to global failure of the material above a certain strain.

### Vacuum Ellipsometry as a Method for Probing Glass Transition in Thin Polymer Films

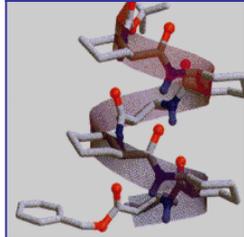
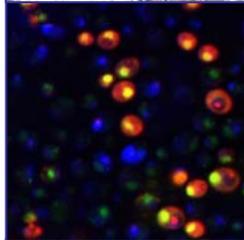
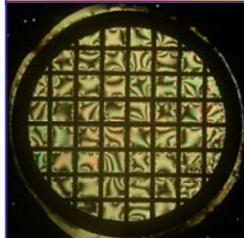
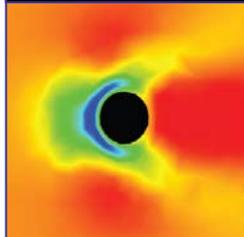
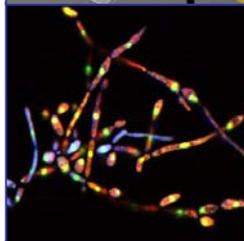
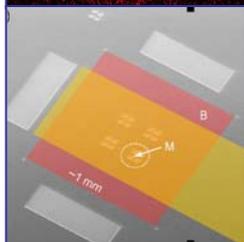
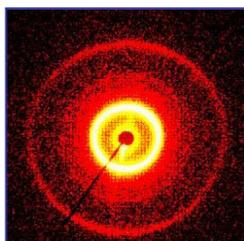
M. Y. Efremov, S. S. Soofi, A. V. Kiyanova, C. J. Munoz, P. Burgardt, F. Cerrina and P. F. Nealey

*Review of Scientific Instruments* **79**, 43903 (2008)

#### Abstract:

A vacuum ellipsometer has been designed for probing the glass transition in thin supported polymer films. The device is based on the optics of a commercial spectroscopic phase-modulated ellipsometer. A custom-made vacuum chamber evacuated by oil-free pumps, variable temperature optical table, and computer-based data acquisition system was described. The performance of the tool has been

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demonstrated using 20-200 nm thick poly(methyl methacrylate) and polystyrene films coated on silicon substrates at  $10(-6)$ - $10(-8)$  torr residual gas pressure. Both polymers show pronounced glass transitions. The difficulties in assigning in the glass transition temperature are discussed with respect to the experimental challenges of the measurements in thin polymer films. It is found that the experimental curves can be significantly affected by a residual gas. This effect manifests itself at lower temperatures as a decreased or even negative apparent thermal coefficient of expansion, and is related to the uptake and desorption of water by the samples during temperature scans. It is also found that an ionization gauge--the standard accessory of any high vacuum system--can cause a number of spurious phenomena including drift in the experimental data, roughening of the polymer surface, and film dewetting.

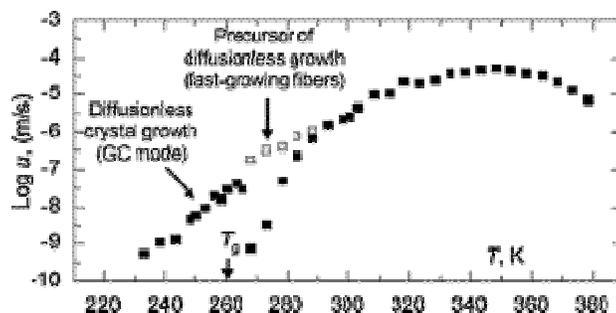
## Diffusionless Crystal Growth from Glass has Precursor in Equilibrium Liquid

Y. Sun, H. Xi, M. D. Ediger and L. Yu

*Journal of Physical Chemistry B* **112** (3), 661-664 (2008)

### Abstract:

A remarkable property of certain glass-forming liquids is that a fast mode of crystal growth is suddenly activated near the glass transition temperature,  $T_g$ , and continues in the glassy state. This mode of growth, termed GC (glass-crystal), is so fast that it is not limited by molecular diffusion in the bulk liquid. We have studied the GC growth by growing multiple crystal polymorphs from the liquid of ROY, currently the top system for the number of coexisting polymorphs of known structures. We observed a new feature of GC growth that conflicts with its current description in the literature. We found that the GC mode is not truly a new growth mode suddenly appearing near  $T_g$  but one already existing in the equilibrium liquid up to approximately  $1.15 T_g$ , in the form of fast-growing fibers. This finding is relevant to testing different explanations for GC growth and favors the view that GC growth is enabled by molecular motions that are native to the glass but still persist in the viscous liquid.



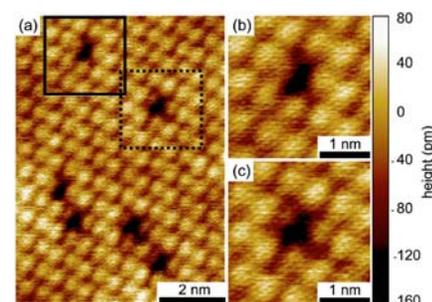
## Molecular-Scale Structural Distortion Near Vacancies in Pentacene

S. Seo, L. C. Grabow, M. Mavrikakis, R. J. Hamers, N. J. Thompson and P. G. Evans

*Applied Physics Letters* **92**, 153313 (2008)

### Abstract:

Molecular vacancies form in both of the crystallographic basis sites of thin pentacene crystals. Features in scanning tunneling microscopy images of these crystals correspond to the exposed terminal atoms of molecules. The (001) and (00 $\bar{1}$ ) surfaces of pentacene are distinguishable, which allows for the identification of the absolute orientation of crystals and for the unambiguous assignment of the position of molecules relative to each vacancy. For vacancies in each molecular basis site of the pentacene (001) surface, the image feature associated with one molecular nearest neighbor is displaced by significantly more than other molecules.



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