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NANONEWS

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Electron-Induced Superhydrophobicity of Nanoparticles

Ilya Torchinsky , Michel Molotskii, and Gil Rosenman

Controllable modification of nanoparticles wettability allows both understanding fine physical mechanism acting on their surfaces, and improvement of key properties in a number of nanotechnology applications. The modification of nanoparticles generating superhydrophobic state arouses especially a strong interest, since various physical phenomena, such as such as sticking, agglomeration, friction of nanoparticles are defined by wettability properties. Today the developed technologies mainly apply diverse modification methods changing chemical identity of nanoparticle surfaces by means of intermediate layers of different chemical nature.

We developed a new concept based on defect free low energy electron-induced surface energy modification. It has been found that electron-irradaited ZnO-nanoparticles strongly change their wettability from superhydrophilic to superhydrophobic state.[1,2]

Pronounced variation of wettability from high hydrophilic state to superhydrophobic has been observed in ZnO-nanoparticles (the average particle size was 200 nm), irradiated by low energy electrons (300eV). The untreated nanopaticles easily adsorb the deposited water droplets and water, wetting the nanoparticles, penetrates inside ZnO-nanopowder in a short time ~0.2sec (Fig.1). Electron irradiation dramatically changes the water droplet behavior on the ZnO nanopaticle sample surface (Fig.2). The water does not wet the surface and does not penetrate inside the micrometer-size pores between individual nanoparticles and their aggregates. Finally we did not succeed to "paste" the droplet to the surface. Moreover, the last image shows that the droplet is pushed off the surface (Fig. 2). Such a behavior of the water droplets is a direct evidence of superhydrophobic properties of the electron treated surface of ZnO- nanomaterial.

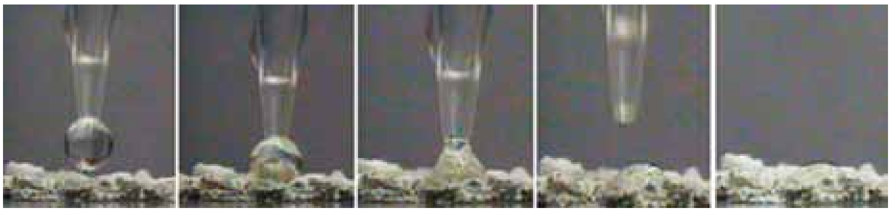


Fig.1 Camera snapshots. Time interval between the pictures is 50ms. 2µl water drop lands on an untreated ZnO powder surface and totally penetrates in ~200 ms.

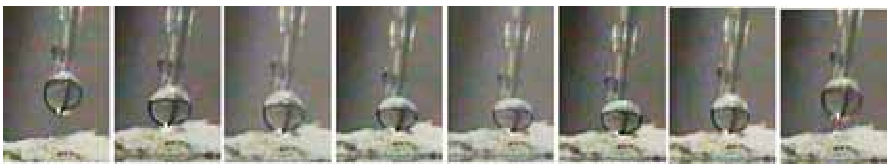


Fig.2 Camera snapshots. Time interval between the pictures is 200ms. 2µl water drop cannot be detached from the pipette and placed on a irradiated ZnO powder superhydrophobic surface.

The observed effect is consistent with developed theoretical model, which shows that even at micrometer values of pore's radius, we may see only small sag~0.1µm of drops over a pore. As a result, a water droplet, contacting to the nanopowder, does not wet nanoparticles, it only sits on surface protrusions, without the appreciable sagging under the gravitation forces.

The found effect and developed "green" technology of nanoparticle surface modification is the basis for engineering of other related to wettability surface properties such as hygroscopicity and agglomeration and it may be applied in a number of nanotechnology applications

1 Michel Molotskii, Ilya Torchinsky and Gil Rosenman, Physics Letters A 373 (2009) 804–806

2 Ilya Torchinsky , Michel Molotskii and Gil Rosenman, Applied Physics Letters, submitted

New Tools and software

ATV RV-129 Diamond Scriber

ATV RV-129 Diamond Scriber performs fast, easy and precise scribing and cutting of silicon wafers, as well as thin- and thick film ceramic and glass substrates.

It forms the grooves necessary for effective glass or ceramic cutting; shallow, even and continuous.

All essential operating parameters - the angle of the scribing tool, the scribing force, the touchdown point and the lift up point of the tool are precisely adjustable to ensure optimal flexibility and repeatable results. The scriber has got a rotating X - Y table with universal vacuum chuck for any size wafers up to 8″ diameter or ceramic substrates up to 8″ x 8″.

The X adjustment is performed by a precision ball screw with a digital readout ± 10µm. The table with chuck is moveable in the Y (scribing) direction by hand. The scribing tool touches down the substrate or wafer surface on an adjustable touchdown point and is automatically lifted after leaving the scribing area. The lift-up point is adjustable too.

The lowering and lifting of the tool can also be performed manually.

A 50 X magnification Microscope with cross hair and coaxial illumination can be aligned with the trace of the diamond so that the paths of the water

or the substrate, where the cut have to be performed, need to be aligned with the cross hair of the microscope.

Brewer Science Cee® 100 Spray Developer

Brewer Science Cee® 100 Spray Developer utilizes two spray nozzles to apply developer solution and deionized (DI) water.

The spray developer uses an open lid with spray nozzles mounted outside the wafer plane, spraying inward from the center of the wafer out.

This unit uses 1-gallon pressure cans as the reservoirs for the solutions.

A maximum of four spray nozzles can be used to apply developer solution and DI water

Specifications:

- User-friendly touch screen interface and display
- 700 process programs
- 20 steps per program (upgradeable with software option)
- 0.1-second resolution for step times
- Spin speed: 0 to 6,000 rpm
- Spin speed acceleration:
- 0 to 30,000 rpm/sec unloaded
- 0 to 23,000 rpm/sec for a 200 mm substrate
- 0 to 3,000 rpm/sec for a 6″x6″x.250″ photomask recessed chuck
- PC compatible: Ethernet port for uploading/downloading process parameters standard
- Simultaneous dual automated dispense capability
- Spin speed repeatability: < 0.2 rpm
- Spin speed resolution: < 0.2 rpm
- Substrate sizes (< 1 cm to 200 mm round / 6″ x 6″ square)

ProSys Tabletop Megasonic System

The megasonic cleaning technique is effective for removing sub-micron particles from silicon wafers and other products, without damage. The method is currently being used by manufacturers of integrated circuits, flat panel displays, and hard disks, as well as by mask makers and raw silicon suppliers.

Megasonic cleaning may be used with a variety of chemistries. Although it is used primarily for particle removal, it may also be used to increase the efficiency of chemical cleaning with surfactants or detergents. Removal of other contaminants depends on the solutions in the tank.

The versatile ProSys Table Top Megasonic cleaner can clean a wide variety of components. The cleaning chemistry is filtered and recirculated.

Overhead View

Specifications:

- Teflon Tank 10cm x 23cm with an active array of 2.5cm x 20cm
- Quartz Insert Option for Strong Acid and Base Use
- Transducer Array and Controls, 1 MHz frequency
- Operating Temperatures to 60° C
- 200 Watt RF Power Supply
- Single Wafer, Die Or Special Parts Cleaning
- Custom Part Fixtures Available
- LCD Touch Screen Operator Control Panel

More info: **http://www.prosysmeg.com/**

Research news

Nanometer-sized molecular transistors

Elad Mentovich, M. Gozin and Shachar Richter

One of the most important key issues in electronics the theoretical experimental limitations for device miniaturization, and the physics related to this phenomenon. Recently, PhD student Elad Mentovich from the group of Dr. Shachar Richter from the School of Chemistry and the Center for nanoscience and nanotechnology has demonstrated a new type of device that might help to explore this critical issue. In recent issue of "nano letters" the group demonstrated a universal method for the mass production of nanometer-sized vertical transistors in which ***single layer*** of molecules is used as the active part of a transistor device. Mentovich used special types of molecules and proteins (synthesized by the group of M. Gozin from the school of chemistry) that exhibit self assembly properties to define the active size of a 1-4 nm-sized (!) transistor and explore its properties. It was found that the transistor was extremely sensitive to the type and composition of the molecular layers embedded within it and therefore it can be also used as a reliable powerful tool for investigation of transport phenomena on the molecular scale.

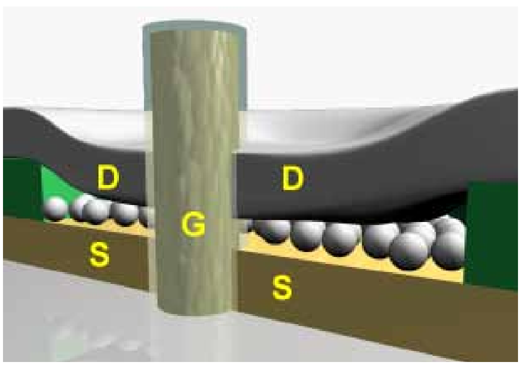
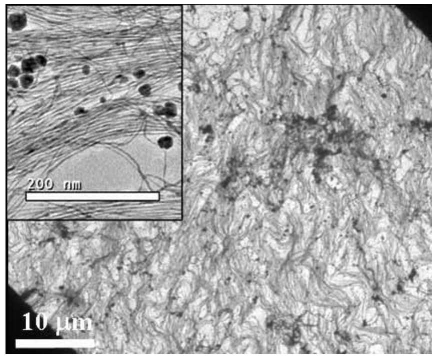


Figure 1 Scheme of the Central Gate Molecular Vertical Transistor (C-Gate Molvet). Metallic source and drain electrodes (S,D) are used to pass current through single molecular layer. A third gate oxide electrode (G) is utilized to modulate the current

Transparent and conductive metal nanowire films

Daniel Azulai, Tatyana Belenkova, Hagit Gilon and Gil Markovich



A simple wet chemical process for the deposition of ultra-thin (~3 nm wide) gold-silver nanowire network films was developed. It is based on a concept similar to the preparation of mesoporous materials which use an organic surfactant template for the formation of ordered porous ceramic materials. In this process a thin solution film is spread over a substrate and dried while a metal reduction process is taking place. The solution contains a high surfactant concentration as well as gold and silver precursors. When the film dries, the increasing surfactant concentration leads to the formation of liquid crystalline phases combining surfactant, metal ions and reducing agent and the metal deposits in tubular mesostructures formed in the film. The resulting metal nanowire films have conductivity and transparency levels comparable to indium-tin-oxide (ITO), which is the transparent electrode material used in many opto-electronic applications. This makes them good candidates for replacing the ITO in some of these applications.

Mapping the active Dopant distribution in an individual Vapor-Liquid-Solid Silicon nanowire

Elad Koren, Noel Berkovitch and Yossi Rosenwaks

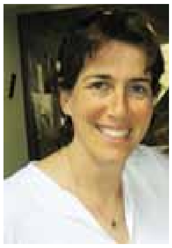
Semiconductor nanowires are one of the most promising building blocks for near future nano-electronics because they provide a new route to continuing miniaturization as well as a wealth of opportunities in nanoscale science and technology. The vapor-liquid-solid (VLS) growth process is one of the most widely used nanowire growth methods, because it offers excellent control of nanowire size and composition. However, the concentration and distribution of the active dopants are still unknown and remaining a challenge towards the realization of high quality electrical devices. We have used Kelvin probe force microscopy (KPFM) to map both the longitudinal and radial active dopants distribution within a single n-type silicon nanowire grown by the vapor-liquid-solid method. Our results show a radially decaying dopant concentration from the surface toward the wire core, with a difference of almost two orders of magnitude. Furthermore, we have been able to extract the diffusion coefficient of the dopant phosphorous atoms in the silicon nanowires, D=1x10-19 m2 s-1. This understanding of both the intentional and unintentional doping within silicon nanowires and their correlation with the electrical properties are highly important towards the realization of high quality electrical devices.

Make your recent discoveries known by sending a short description to **nanonews@eng.tau.ac.il**

New faces in the Center

Ella Sklan, Faculty of Medicine

Viruses are nanoscale particles that infect the cells of a biological organism. A typical virus consists of genetic material contained within a protective protein coat. Some viruses have an envelope of phspholipids that surrounds them when they are outside a cell. From a material scientist viewpoint, viruses can be regarded as organic nanoparticles. Viruses cannot reproduce by themselves and thus they use the machinery and metabolism of a host cell to produce multiple copies of themselves, and to assemble in the cell. Thus, host factors are involved in most, if not all, steps of viral life cycle.



In spite of more than a hundred years of research it is still unknown how most viruses conquer the cells they infect. A tragic consequence of our lack of deep understanding of viruses is our incompetence in producing adequate therapies. For example millions of people around the world are infected with Hepatitis C virus, a major cause of liver transplantation and liver cancer. Most patients infected with Hepatitis C don't respond to current treatment, causing vast economical damages and devastating loss of life.

Our research aims to identify and study protein-protein and other interactions between these viruses and their host cells. Our current projects include the development of unique yeast and mammalian systems for the identification of new interactions between viral and host cell proteins and the development of high-throughput screens to identify small molecules that inhibit previously identified interactions between viral and host proteins.

Better understanding of the life cycle of the Hepatitis C virus will provide opportunities for innovative therapies applicable not only against Hepatitis C virus, but also against other closely related viruses causing life threatening diseases such as Dengue fever, Yellow fever and Viral encephalitis.

Dr. Sklan received her PhD from the Life Sciences Institute of the Hebrew University of Jerusalem. She then moved to the division of gastroenterology and hepatology at the Stanford school of medicine.

5th Workshop of the Center for Nanoscience and Nanotechnology

Ron Lifshitz and Shachar Richter, 5th Workshop Co-Chairs

The Tel Aviv University Center for Nanoscience and Nanotechnology held its 5th Annual Workshop last February in Kibutz HaGoshrim. The Workshop offered a unique opportunity to discuss the latest developments in nanoscience and nanotechnology on campus, and featured a broad spectrum of lectures by speakers from all participating disciplines in the University. The Workshop hosted a number of leading guest speakers from abroad. These included Julio Fernandez from Columbia University, who gave the honorary Fred Chaoul Lecture, as well as Aharon Kapitulnik from Stanford University and Andreas Herrmann from the University of Groningen.

The Workshop featured a poster session accompanied by the traditional "flash session" with short, engaging, and often humorous, presentations by our students. These presentations clearly attested to the vigorous research performed on campus. Prizes sponsored by NTMDT were awarded for the best presentations to Naomi Ittah, Oren Shaya and Lilach Vaks.

We hope that the workshop fostered new cross-discipline friendships and collaborations, and contributed to the ongoing effort to make the impact of the Center greater than the simple sum of its parts. Bridging the interdisciplinary gaps and overcoming the linguistic and conceptual barriers was difficult as always, but we are clearly doing better with each new Workshop. We look forward to more of this kind of stimulating interaction at the upcoming 6th Workshop, and wish great success to its Co-Chairs, Yoram Dagan and Dan Peer.

Lastly, we would like to thank our co-members on the Scientific Committee, Itai Benhar, Noam Eliaz, and Ronit Satchi-Fainaro, as well as the Head of the Center, Ori Cheshnovsky, for their help in setting up the program. We also wish to thank Moshe Evenor, Lauren Itzhak, and Ruth Peretz for taking care of all the administrative work.

Videos of the lectures can be accessed at: http://video.tau.ac.il/Lectures/nano/2009/Hagoshrim/

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