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The Magazine for Nanotechnology

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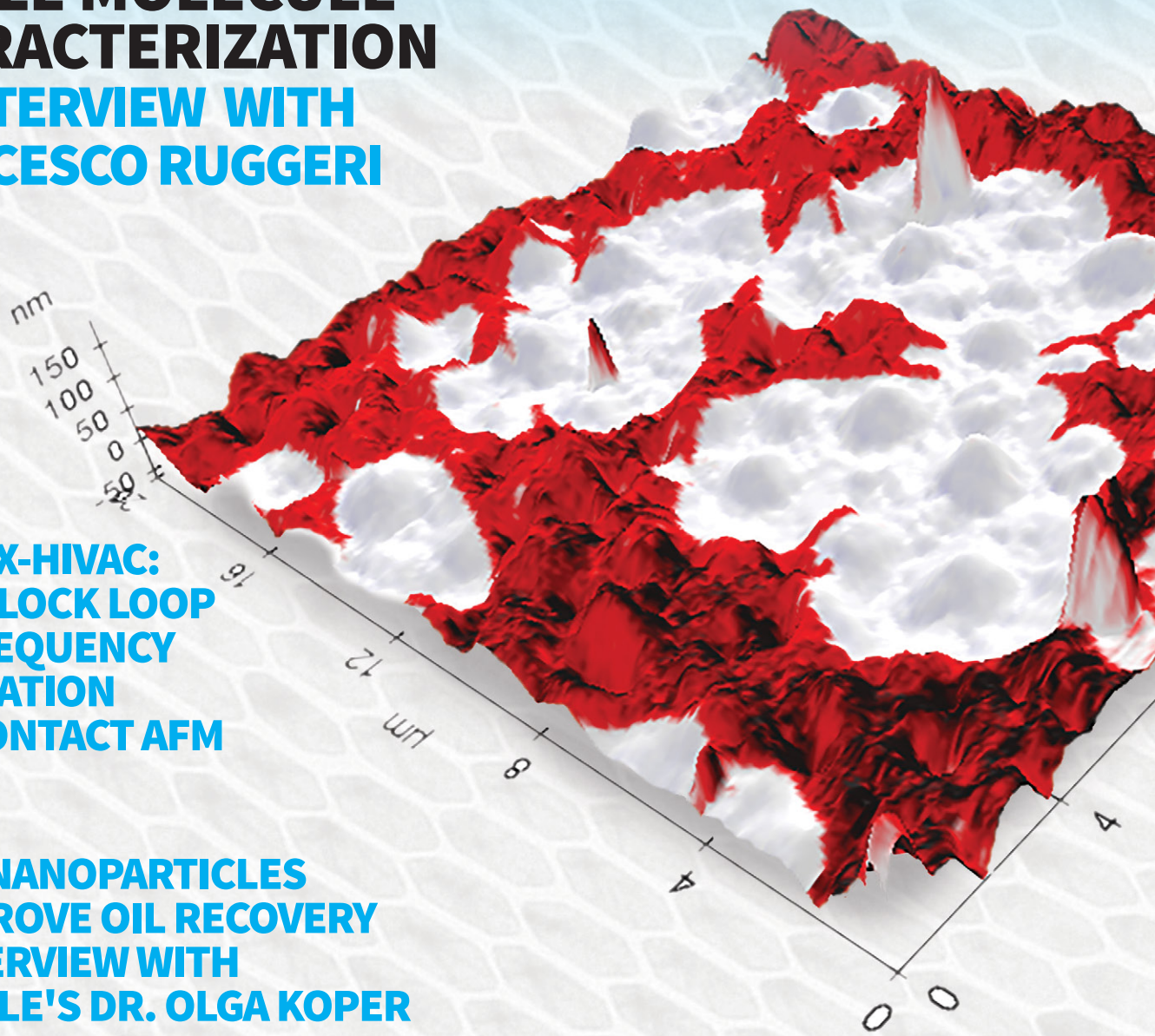

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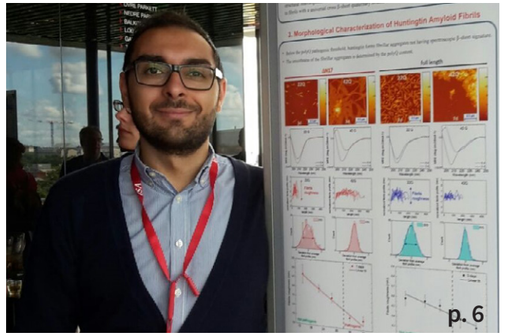

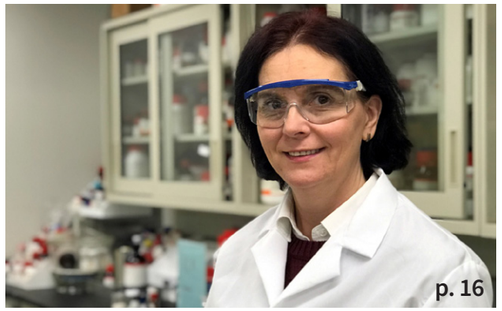

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For inquiries about submitting story ideas, please contact Deborah West, Content Editor at debbie@nano-scientific.org. For inquiries about advertising in NANOscientific, please contact Gerald Pascual at gerald@nano-scientific.org

Park SYSTEMS

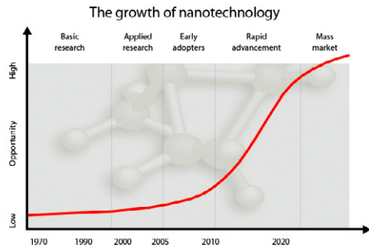
INSET PHOTO ON COVER:
Image of a composite polymer sample (20 µm x 20 µm scan size). Lateral force microscopy (LFM) mode on a Park Systems atomic force microscope (AFM) was used to create this image. Here, data for both topography and surface friction characteristics of a composite polymer sample spun unto a glass substrate were acquired. The regions in white were observed to be less sticky than those in the red and dark regions.

Keibock Lee, Editor-in-Chief

MESSAGE FROM EDITOR

Hello and Happy New Year

2017 was an amazing year for nanotechnology, where industries are beginning to see the results of astonishing research made possible through the explosion of nanoscience research world-wide. As new findings culminate into collective mass market products, (shown in graph below) nanotechnology is indeed living up the prediction of the National Science Foundation of becoming a trillion dollar industry and forever changing our world.



With significant improvements in virtually every industry, made possible through research and industry collaborations, nanoscience continues to expand our ability to heal ourselves and create sustainable solutions for a better world. In this issue, we highlight new discoveries and the application tools making them possible. In our first article we showcase the research being done at University of Cambridge by Francesco Ruggeri at the Center for Misfolding Diseases where identifying single molecule characterizations by using AFM is helping to find cures for neurological diseases like Alzheimers.

We also bring you exciting news about the grand opening of the new Park Nanoscience Center at SUNY Polytechnic Institute, one of the world's most advanced high-tech education and research and development sites. Park received a tremendous welcome from SUNY Poly as demonstrated in this statement by Dr. Bahgat G. Sammakia, Interim President of the SUNY Polytechnic Institute, ***"SUNY Poly is thrilled that a worldwide leader in atomic force microscopy is selecting the campus for its newest location, and we warmly welcome Park Systems as we look forward to working closely to advance research capabilities in this important area."***

And we showcase a technique developed with Zurich Instruments for combining Zurich Instruments HF2PLL with Lock-in Amplifier [HF2LI]) with a Park Systems AFM [Park NX-Hivac]. This combination enables capabilities such as frequency modulation AFM, which allows researchers to observe the dynamic properties of an oscillating cantilever which can be used to quantify surface potential measurements.

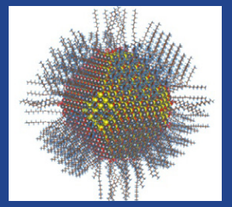
We also have a feature interview in this issue with Dr. Olga Koper highlighting a new very promising green chemistry method under development at Battelle using a soy-based surfactant. She also discusses other exciting research at Battelle using nanoparticles and nanofluids (solutions containing nanoparticles 1-100 nm in dimension).

We have a technical article presenting details on lateral force microscopy, a mode derived from atomic force microscopy developed for nanoscale frictional measurement, or nanotribology. This technique, as demonstrated in the article, is particularly powerful in identification and mapping of the relative difference in frictional characteristics with superior spatial resolution.

Lastly, we feature two additional recipients of the Park AFM Scholarship. So far, Park has given this recognition to ten outstanding researchers at some of our most distinguished institutions and this year, Park AFM Scholarships will expand globally to continue helping researchers advance nanoscale discoveries.

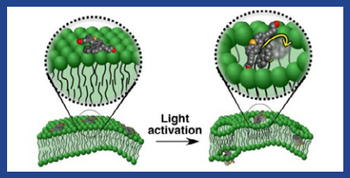
In each issue of NanoScientific, we provide informative articles about nanotechnology trends balanced with leading edge scientific research applications and concepts. As always, I encourage readers to submit your comments, story ideas, and user experiences. I hope you enjoy this issue and best wishes in the New Year.

Future timeline highlights discoveries that improve healthcare, energy and more as scientists world-wide continue to make astonishing breakthroughs using nanotechnology

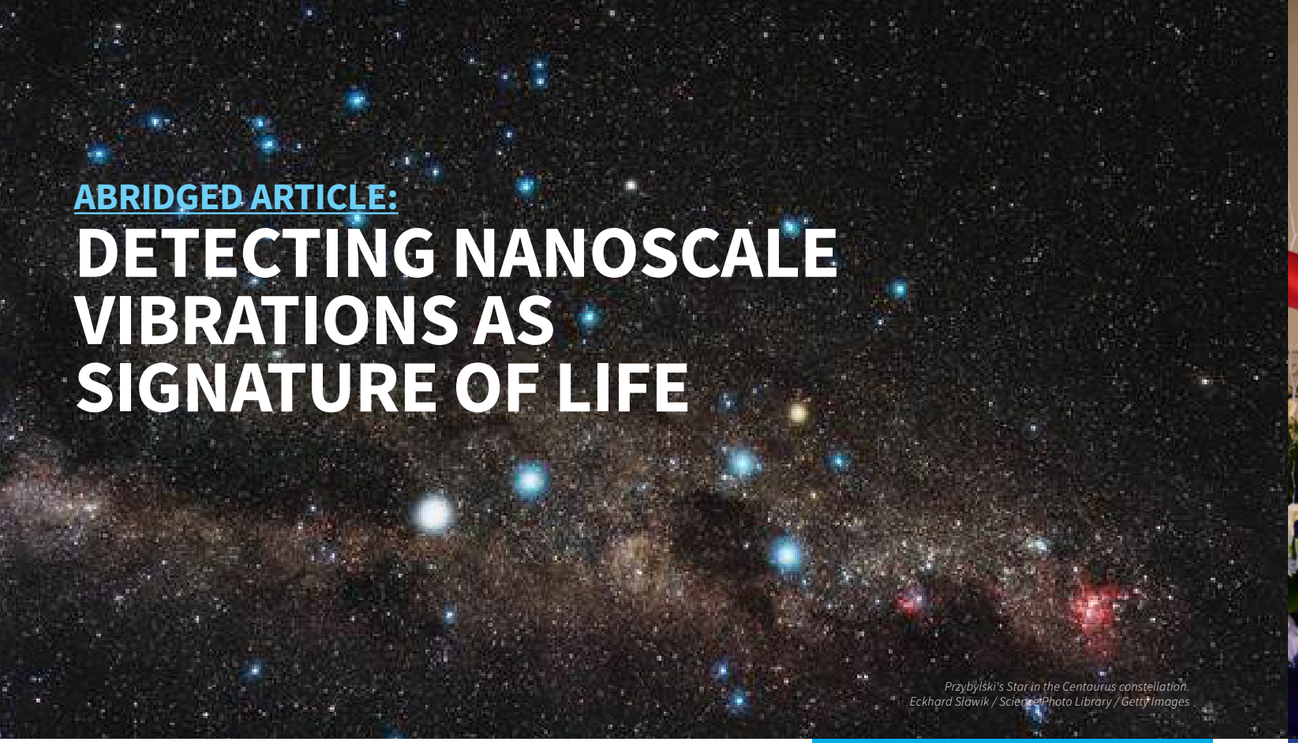


Researchers at the U.S. Department of Energy's (DOE) National Renewable Energy Laboratory (NREL) have set a new world efficiency record for quantum dot solar cells, at 13.4%. Colloidal quantum dots are electronic materials and because of their astonishingly small size (typically 3-20 nanometers in diameter) they possess fascinating optical properties. Rapid improvements in quantum dot solar cells have pushed that number into double digits. Progress from the initial low efficiency came from better understanding of the connectivity between individual quantum dots, better overall device structures, and the prevention of defects in each dot.

Researchers at Texas A&M working with Los Alamos National Laboratory have found a way of protecting the materials in fusion reactors from degradation caused by helium, using nanocomposite solids, which could make fusion energy viable. Nuclear fusion, is the process that powers main-sequence stars like the Sun. If harnessed, it would provide unlimited clean energy. However, constructing a fusion power plant has proven to be a daunting task, in part because no materials can adequately withstand the conditions found in a reactor core. Now, researchers at Texas A&M University have discovered a way to use materials that may be suitable by investigating how helium behaves in nanocomposite solids, materials stacked into thick metal layers. Rather than making bubbles, the helium in these materials formed long channels, resembling veins in living tissues. This discovery paves the way to helium-resistant materials needed to make fusion energy a reality.



Researchers at Durham University, North Carolina State University, and Rice University have demonstrated, in lab tests, how rotors in single-molecule nanomachines can be activated by ultraviolet light to spin at three million rotations per second and pierce the membranes of cancer cells to kill them within 60 seconds. The motor itself is a paddle-like chain of atoms that can be prompted to move in a single direction when supplied with energy and made to spin when activated by a light source. The motors, nanomachines so small you could put 50,000 of them across the diameter of a human hair, can target a cell's 8-10 nm lipid bilayer membrane and then either tunnel through to deliver drugs or other payloads, or disrupt it and kill the cell.



Przybylski's Star in the Centaurus constellation.
Eckhard Slawik / Science Photo Library / Getty Images

ABRIDGED ARTICLE:

DETECTING NANOSCALE VIBRATIONS AS SIGNATURE OF LIFE

Original article by Sandor Kasas[ab], Francesco Simone Ruggeri[a], Carine Benadiba[a], Caroline Maillarda, Petar Stupar[a], Hélène Tournu[c], Giovanni Dietler[a], and Giovanni Longo[a]

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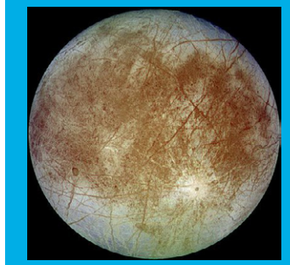
Abridged by Park Technical Staff

Based on the principle that one of the common signatures of life is movement, because even small microorganisms vibrate in response to their metabolic activity, research done in 2014 with Francesco Simone Ruggeri and others explored the use of an innovative nanoscale motion sensor that could be used in life-searching experiments in Earth-bound and interplanetary missions. This nanomotion detector is used to study these fluctuations and associate them to the metabolic activity of the specimens. This technique does not measure the chemical response of life, which would require prior knowledge of the metabolic pathways involved. Instead, it monitors the physical manifestation of any kind of metabolic activity the microorganisms might have. This research showed how this nanomotion detector can study any living system, paving the way to a complementary approach to the study of life in extreme environments.

The working principle of the technique may be summarized as follows. A microfabricated atomic force microscopy (AFM) cantilever is inserted into an analysis chamber, and specimens are attached to its surface. The cantilever transduces the movements of the samples with a sub-nanometer resolution. The dynamic deflections of this sensor are detected and recorded using a laser-based transduction system. The time resolution and sensitivity of this system make it ideal to study living specimens at the nanoscale. It can be operated in air or in a liquid environment; in this latter case, the living specimens can be exposed to triggering or inhibiting chemicals to characterize their response to the stimuli.

AFM proved to be a valuable technique to exploit the sensitivity of nanomechanical oscillators to transduce the small fluctuations that characterize living systems. By combining chemical and dynamical measurements, this method could help future missions seeking to explore the presence of life on satellites of the giant planets, such as Europa (Jupiter) or Titan and Enceladus (Saturn).



Europa, one of Jupiter's moons, has an icy shell, but scientists believe there is an ocean beneath.

Since Europa has water, future missions will search for signs of life. In February, NASA received a report for a possible landing mission to Europa, which has been in the works since June 2016. In the landing mission, a probe will search for evidence of life on Europa, assess its habitability, and characterize the surface and subsurface for future explorations to this moon and its ocean.

This ocean has at least twice as much water as Earth's oceans. While recent discoveries have shown that many bodies in the solar system either have subsurface oceans now, or may have in the past, Europa is one of only two places where the ocean is understood to be in contact with a rocky seafloor (the other being Saturn's moon Enceladus). This rare circumstance makes Europa one of the highest priority targets in the search for present-day life beyond Earth.

GRAND OPENING OF THE PARK NANOSCIENCE CENTER AT SUNY POLYTECHNIC INSTITUTE

RIBBON CUTTING CEREMONY AT THE GRAND OPENING OF THE PARK NANOSCIENCE CENTER AT SUNY POLYTECHNIC INSTITUTE ON NOV. 10, 2017

Pictured (left to right): Dr. Ryan Yoo, Vice President of Sales at Park Systems, Mr. Keibock Lee, President and General Manager at Park Systems, Dr. Sang-il Park Chairman & CEO from Park Systems, Prof. Alain Diebold, Interim Dean at the College of Nanoscale Science at SUNY Polytechnic Institute, Dr. Ardavan Zandiatashbar, Technical Accounts Manager and Sr. Applications Scientist at Park Systems

The Park Nanoscience Center in Albany, NY is a new branch of Park Systems and will showcase advanced atomic force microscopy (AFM) systems, demonstrate a wide variety of cutting-edge applications—ranging from materials science, to chemistry and biology, to semiconductor and data storage devices—and provide hands on experience, training and service, year-round.

The Center's grand opening at the State University of New York Polytechnic Institute (SUNY Poly), one of the world's most advanced high-tech education, research and development sites, was held on November 10, 2017 at 2 PM. The Center is located in the NanoFab East Building of SUNY Poly's Albany campus and is designed to become a hub for globally advanced metrology AFM research activities. It will be equipped with the latest Park AFM systems, including the Park NX20, Park NX10, and Park NX-Hivac. Park Systems, a global AFM manufacturer, has offices in key cities worldwide, including Santa Clara, California; Tokyo, Japan; Singapore; Heidelberg, Germany; and Suwon and Seoul, South Korea.

SUNY Poly's Albany NanoTech Complex is home to the College of Nanoscale Sciences and the College of Nanoscale Engineering and Technology Innovation and is a fully-integrated research, development, prototyping, and educational facility that provides strategic support through outreach, technology acceleration, business incubation, pilot prototyping, and test-based integration support for onsite corporate partners, including IBM, GlobalFoundries, Samsung, TSMC, Applied Materials, Tokyo Electron, ASML, and Lam Research, as well as other next-generation nanotechnology-based research activities.

"As SUNY Polytechnic Institute provides cutting-edge educational and research and development opportunities, it is exciting that Park Systems will establish operations at our Albany campus," said Dr. Alain Diebold, SUNY Poly Interim Dean of the College of Nanoscale Sciences; Empire Innovation Professor of Nanoscale Science; and Executive Director, Center for Nanoscale Metrology. "Our scientists and engineers look forward to working closely with Park Systems to enhance next-generation technologies that will lead to improved metrology capabilities for researchers and members of industry around the world."

"SUNY POLY IS THRILLED THAT A WORLDWIDE LEADER IN ATOMIC FORCE MICROSCOPY IS SELECTING THE CAMPUS FOR ITS NEWEST LOCATION, AND WE WARMLY WELCOME PARK SYSTEMS AS WE LOOK FORWARD TO WORKING CLOSELY TO ADVANCE RESEARCH CAPABILITIES IN THIS IMPORTANT AREA,"

- DR. BAHGAT G. SAMMAKIA, INTERIM PRESIDENT OF THE SUNY POLYTECHNIC INSTITUTE, THE WORLD'S MOST ADVANCED, UNIVERSITY-DRIVEN RESEARCH ENTERPRISE AND HOME OF PARK SYSTEMS NEW NANOSCIENCE CENTER

Pictured (left to right): Dr. Tae-Gon Kim, Senior Researcher from imec, Mr. Phil Kaszuba, Senior Member of Technical Staff from Global Foundries, Dr. Sang-il Park, Chairman & CEO from Park Systems, Dr. John Allgair, 2.5D/3D Program Manager for BRIDG at the University of Central Florida, Dr. William Wilson, Executive Director of the Center for Nanoscale Systems at Harvard University, Prof. Gwo-Ching Wang, Travelstead Institute Chair Professor at Rensselaer Polytechnic Institute

PARK NANOSCIENCE CENTER GRAND OPENING EVENT

In his opening remarks at the ceremony Dr. Sang-il Park, Park Systems Chairman & CEO, highlighted Park Systems' continued growth and success as the world leading atomic force microscope manufacturer for over two decades. This year marks the 20th anniversary for Park Systems and in 2015 the company went public, becoming the only successful public offering for an AFM business. Since the IPO, their stock has increased by 168% and many companywide growth initiatives have set the platform for continued future success.

Park's recent accomplishments include expansion of their Korean facility and the creation of a new advanced cleanroom.

They also opened offices in Taiwan, Germany, and Singapore, and added key personnel for global expansion. The opening of the Park Nanoscience Center at SUNY Polytechnic Institute adds Park Systems to a prestigious list of material suppliers, equipment suppliers, and IC manufacturers at that location.

SUNY Polytechnic is a very semiconductor-centric site. "We have a national treasure here in terms of a robust ecosystem for semiconductor research," commented Dr. Alain Diebold, SUNY Poly Interim Dean of the College of Nanoscale Sciences; Empire Innovation Professor of Nanoscale Science; and Executive Director, Center for Nanoscale Metrology. Dr. Diebold emphasized that the new Park AFM can solve challenges in measurement in material science as well.

"WE ALSO HAVE NANOBIOLOGISTS HERE AT SUNY WHO ARE EXCITED TO USE THE PARK AFM TO LOOK AT CELLS IN VARIOUS ENVIRONMENTS AND ALL THE VARIOUS BIOLOGICAL APPLICATIONS." DR. DIEBOLD WAS ONE OF THE INVITED GUESTS WHO SPOKE AT THE PARK NANOSCIENCE GRAND OPENING CEREMONY.

Park SYSTEMS

"PARK SYSTEMS AND RPI HAVE A SPECIAL HUMAN CONNECTION BASED ON A COMMON PHILOSOPHY OF DEVELOPING A FUTURE GENERATION WORK FORCE AND A STRONG EMPHASIS ON TECHNOLOGY INNOVATION AND SCIENTIFIC DISCOVERY."

Professor Gwo Ching Wang from Rensselaer Polytechnic Institute (RPI)

Prof. Gwo Ching Wang from Rensselaer Polytechnic Institute also spoke at the opening ceremony. She remembers RPI's first connection with Park Systems and said in the early days their Park AFM was and still is a workhorse for their group. Not only do the PhD and master's students use the AFM for research, but every one of their physics undergrads uses Park AFM in their experimental physics class.

Dr. John Allgair, 2.5D/3D Program Manager for BRIDG at the University of Central Florida said he is very excited that Park is opening a center at SUNY Poly and said they will use the Park AFM equipment in their development of a smart sensor fabrication system which will focus on images. The advanced and technically sophisticated smart sensor system will be built on a chip and will be useful for numerous applications such as autonomous cars.

"We will use Park AFM for surface analysis to support wafer bonding and die bonding and to integrate heterogeneous systems for surface activation bonding for just a couple of examples," commented Dr. Allgair at the Park Nanoscience Center Grand Opening. "We have a high need for compositional analysis using Park AFM and are very impressed with the versatility of the Park AFM system."ed with the versatility of the Park AFM system."

Dr. William Wilson, Executive Director of the Center for Nanoscale Systems (CNS) at Harvard University, welcomed Park Systems to SUNY Polytechnic Institute in his speech. Harvard CNS provides a collaborative multidisciplinary research environment to support world-class nanoscience and technical expertise. The northeast is a hub for everything nanoscience and collaborative research facilities serve an important and vital role in shared knowledge and research opportunities.

"THE PARK NX-3DM AFM RUNS 24 HOUR NON-STOP IN OUR (IMEC) WAFER FABRICATION OPERATION AND IS THE ONLY AFM THAT CAN DELIVER SIDEWALL VISUALIZATION WITH A STURDY ROBUST AND ACCURATE PLATFORM AND UNIQUE NON CONTACT TECHNOLOGY."

imec Senior Researcher, Dr. Tae-Gon Kim

Dr. Tae-Gon Kim, who has spent years at imec working on developing integrations for Park AFM into various industrial processes, says this is just the beginning for the uses of Park Systems' patented true non-contact mode single probe AFM.

Mr. Phil Kaszuba, Senior Member of Technical Staff from GlobalFoundries, said that Park AFM scanning probe microscopy technology has evolved into a mainstream analytical technique throughout the semiconductor industry over the past twenty years, steadily progressing towards nanoscale microscopy methods currently analyzing images just 26 atoms across. "Park Systems has taken a giant step towards the further advancement of science with the opening of the Park Nanoscience Center at SUNY Poly," states Mr. Kaszuba.

"Increasingly, AFM is being selected for nanotechnology research over other metrology techniques due to its non-destructive measurement and sub-nanometer accuracy," states Dr. Sang-il Park, Park Systems Chairman and CEO. "The new Park Nanoscience Center at SUNY Polytechnic Institute provides researchers with greater access to Park Systems' cutting-edge AFM nanoscopic tools, featuring reliable and repeatable high-resolution imaging of nanoscale cell structures in any environment without damage to the sample."

Park Systems' advanced AFM platform includes Park SmartScan, an innovative and pioneering AFM intelligence that produces high-quality imaging with a single click. SmartScan's unique design opens up the power of AFM to everyone and drastically boosts the productivity of all users. "With Park AFM, throughput is significantly improved and time-to-solution and data reliability are exceptional compared to other metrology solutions," adds Dr. Park.

The Park Nanoscience Center at SUNY Poly will be a unique source for researchers who are looking for the most advanced developments in scanning probe microscopy for materials research, analytical chemistry, life science research, and semiconductor metrology.