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Medical Product Manufacturing News®

THE MAGAZINE FOR MEDICAL PRODUCT DESIGN AND DEVELOPMENT

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SHAPE-MEMORY MATERIALS
Stretch Researchers' Imaginations
PAGE 6

SPECIAL FEATURE
Emerging Technologies
PAGE 22

REGIONAL FOCUS
Inland Empire, CA
PAGE 26

Wave Spring
A wave spring can reduce the size and weight of an assembly by as much as 50%, as compared with round wire compression springs. **Page 8**

Laser welding services
Specializing in joining both similar and dissimilar materials, a company offers laser welding of platinum, tantalum, gold, and stainless steel. **Page 12**

Ecofriendly plastics
A company employs a plastics-making process using catalysts to create polymers whose source materials contain 30 to 50% carbon monoxide and carbon dioxide. **Page 44**

Getting the Ball Rolling

Suited for use in infusion pumps, a line of solid bearings features preinstalled oil-filled polymers for additional lubrication in harsh environments. **PAGE 14**

Medical Product Manufacturing News

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TABLE OF CONTENTS

VOLUME 24 NUMBER 2

Medical Product Manufacturing News

6 Need to Know

- Research is revealing new potential characteristics and functions for shape-memory materials.
- Sandvik Medical Solutions has acquired the Memphis manufacturing facility of Medtronic and JKB Medical Technologies in a move to broaden its capabilities.

12 Spotlight
Joining Technologies

14 Spotlight
Precision Motion Control

18 Outsourcing Outlook
Metal Fabrication

20 Focus on Equipment
Machining

22 Special Feature on Emerging Technologies
MPMN looks at several recent advancements in nanotechnology.

26 Regional Focus
Inland Empire, CA

30 Product Update
Sensors and Transducers

35 Engineering Solutions
A company specializing in testing technologies helped a manufacturer of oxygen conservation devices revise its calibration and test methods.

44 Breakthroughs

- A company has customized performance characteristics of its ecofriendly plastics, which are made with carbon dioxide.
- By incorporating single-crystal silicon transistors, Kopin Corp. has developed what it claims is the world's smallest color SVGA display.
- Medical positioning system technology provides real-time position and orientation information as physicians navigate devices through the human body.

4 Editor's Page

41 Classifieds

42 Advertisers Index

MPMN ONLINE
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EDITOR'S PAGE

A Crash Course in Savings 101

Universities have long played an integral role in medical device development. They've pioneered technologies, licensed discoveries to major industry players, and even spawned spin-out companies of their own. Some colleges are now strengthening their ties to the industry by offering open access to their high-tech facilities—a service that enables higher learning to lower costs for small businesses.

For cash-strapped start-ups, moving from concept to early-stage R&D and prototyping can be a financial burden. Costs associated with the upkeep of a foundry or cleanroom can be astronomical, especially for firms with limited funding. But university-based user facilities offer companies access to state-of-the-art equipment and resources for a reasonable fee. Companies can either rent space in the lab, receive training, and then complete their projects independently, or contract work to the in-house staff.

Dragan Grubisic, general manager for Laser Components (Tempe, AZ), cited the NanoFab at Arizona State University (ASU) as the foundation of a smart business model. "We use this facility for process and device development," he says. "Being a start-up with limited resources, if we had to put money into building a facility like that, I wouldn't be here."

Originally designed to support the semiconductor industry, these fabs offer broad capabilities—catering primarily to micro- and nanoscale characterization and fabrication—that easily translate to medical device development. Many foundries have already hosted users from the medical device sector, facilitating research in such areas as biosensors and MEMS devices for implants. Even industry powerhouses have reaped the benefits. Big companies cannot always justify the expense of equipment for tasks like characterization and failure analysis, and the labs provide an alternative. In fact, Boston Scientific has taken advantage of the resources at the University of Washington's NanoTech User Facility, according to Qiuming Yu, lab manager.

High-volume production is obviously not the goal of these foundries. Rather, the equipment and technology are suited for early-stage experimenting and prototyping. "Having access to a large facility lets researchers try new technologies or equipment," says Sandrine Martin, technical manager at the University of Michigan's fab. Steffan Myhajlenko, associate director of ASU's fab, concurs. "It's an ideal environment for prototyping," he says. "If you have an idea and want to test things out, this is the environment to do it in."

Firms also profit from the extensive knowledge and assistance at hand. Beyond basic training and troubleshooting, the staff often lends expertise in terms of data analysis and advice, according to Yu. Plus, users at sites supported by the National Nanotechnology Infrastructure Network (NNIN) have access to other centers in the 13-school network of user-based facilities that may have complementary capabilities, Martin says. The Universities of Washington and Michigan are members of NNIN, while ASU operates independently.

While economical, these facilities are not cheap to use. And, since these centers are teaching facilities, users run the risk of students making a mistake during contracted work or with the equipment. But, while not perfect, these facilities provide a practical, innovative, and cost-effective opportunity to small medical device firms fretting over the bottom line. And saving money is always a fab idea.

Shana Leonard

EDITOR
shana.leonard@cancom.com

PRODUCTS AND SERVICES

Stepper Drives

A line of stepper drives that are programmable for stand-alone operation are designed for easy integration with other devices on a machine, such as sensors and programmable logic controllers. The ST5-Si drives feature the manufacturer's intuitive Si Programmer Windows-based software with integrated tuning, and a graphical point-and-click format combines motion, I/O, and operator

interface functions to facilitate machine sequencing. Delivering 24 to 48 V dc with output current from 0.5 to 5.0 A, the drives are engineered to protect against overvoltage, undervoltage, overtemperature, and external output shorts. They provide eight digital inputs and four digital outputs. Option boards for adding encoder feedback and RS-485 functionality are available. The drives include self-testing and autosetup features that measure and configure motor parameters automatically, while several specialized functions ensure smooth motion and motor performance.

Applied Motion Products
WATSONVILLE, CA
www.applied-motion.com

Wire Cutter-Stripper

A compact automatic cutting and stripping machine can process a range of wires and cables. With its indexing cutter head and flexible programming, the OmniStrip 9450 is easy to prepare for handling all types of applications. Its intuitive user interface has standard templates for common processes and allows the user to create custom processes for complex jobs. The machine features raw-material and processing libraries that facilitate the programming and editing of multiple jobs. Requiring no compressed air, the electrically powered machine allows for multiple blade sets to be mounted on its cutter head and selected automatically during operation. It can function as a stand-alone unit or in combination with various accessories as a fully automatic cable-processing line.

Schleuniger Inc.
MANCHESTER, NH
www.schleuniger-na.com

FOCUS ON **EQUIPMENT**

Machining

Redesigned Wire EDM Machines Provide Improved Speed and Accuracy

A line of wire EDM equipment has been redesigned to provide faster, more accurate cutting speeds and surface-finishing capabilities for the production of joint-replacement components, surgical knives, needles, clamps, and other medical device components. The new Fanuc iD machines feature a thermally insulated cast Meehanite base designed to provide 40% more rigidity than previous models. Table travel capacity was increased to eliminate load overhang during table movement and to provide high rigidity for heavy workloads. An added air-jet wire transport system in the upper annealing pipe also helps improve accuracy, reliability, and speed.

Methods EDM, a div. of Methods Machine Tools Inc.
SUDBURY, MA
www.methodsmachine.com

Laser Wafer-Scribing Machine Features Optical System for High-Speed Dicing

Featuring a solid-state 266-nm laser, a wafer-scribing and die-singulation machining system uses precision linear motion and part handling to ensure high throughput. The platform of the IX-188 ChromaDice machining center provides flexibility through features such as multiple stages for wafers up to 6 in. and the manufacturer's Vortex nozzle for debris removal. Its optical system for high-speed wafer dicing includes high-precision optical mounts for stability and ease of adjustment. Granite integrated into the machine's structural design can eliminate the need for routine and cumbersome realignment of the optical system. The laser, beam-delivery system, and electronics are fully enclosed. Processing up to five wafers per hour, the machine's noncontact technique provides constant maintenance-free operation, according to the manufacturer.

JP Sercel Associates Inc.
MANCHESTER, NH
www.jpsalaser.com

Precision Machining Center Requires Half the Floor Space of Similar Machines

With a compact footprint of 1.0 × 1.8 m, a precision machining center uses half the floor space of similar machines, according to the manufacturer. To provide high-quality machining of finished surfaces, the Xion-II 5AX features simultaneous five-axis control. High-speed acceleration and deceleration functions minimize downtime, and low electrical consumption results in low operating costs. Designed using 3-D solid modeling, the machining center has no overhanging structures and is approximately 2.0 m tall. Equipped with linear scales, the system creates a fully closed-loop feedback system to achieve positioning accuracy within 0.10 µm. It also features a trunion-style, two-axis rotary table for multisurface processing, and has profile-machining capabilities. Optional accessories include automatic tool and work measurement systems.

Sugino Corp.
ITASCA, IL
www.suginocorp.com

Abrasive Water-Jet System Machines Medical Device Parts and Prototypes

An abrasive water-jet machining system is used to quickly and accurately cut large or multiple stock parts as large as 5 × 10 ft in a variety of materials. The 60120 JetMachining center can be used for applications such as blanking out surgical instruments from special steel alloys, medical device prototyping, cutting artificial limb components from carbon-fiber composites, and water-only applications such as cutting thin plastic for case dividers that hold medical instruments in place throughout the sterilization process. Employing a movable cutting head, the machining center also features a traction drive that achieves high accuracy by closing a positioning loop with linear encoders in the same manner as a linear motor. Its bridge-style y-axis design improves reliability, requiring little maintenance, according to the manufacturer. The system's motion control technology can also calculate the velocity of a tool path at more than 2000 points per inch, enabling precise, rapid machining.

Omax Corp.
KENT, WA
www.omax.com

fischer connectors

New Disposable Low-cost Medical Connector with High Performance

Fischer Connectors introduces a new connector system that promises to satisfy several of the challenges associated with designing and manufacturing disposable medical devices. The new Limited Use Connector (L.U.C.™) offers multiple configurations that allow medical device manufacturers to take advantage of mating low cost, disposable plugs with Fischer's high-performance metal receptacles for continuous use.

The L.U.C. connector's critical feature is the plastic interface piece designed to accept Fischer's standard contact block configurations. The application determines what happens behind this interface connection. What makes the system so accommodating, is that the designer can choose to overmold, utilize a one-piece or two-piece snap-together backshell, or even secure the interface piece right into the handpiece or device itself. The L.U.C. system is ideal for use in virtually any limited-use or disposable medical device, from catheters to surgical hand tools and more.

Additional L.U.C. features include low cost, ease of assembly, lightweight, and the ability to be customized: The connector can accept 2-19 pins with solder or crimp contacts. The possible integration of flex circuits adds to the system capabilities. The L.U.C. two-piece backshell version allows for easy insertion of embedded electronics. Three standard colors are available assisting the user to prevent mismating critical connections. Additional custom color options as well as a customizable area in the overmold to insert items such as company logos are available for added aesthetic and ergonomic features. Parts are capable of withstanding EtO and Gamma sterilization processes, conforming with the requirements of the UL/IEC 60601 directives.

Contact Fischer Connectors for more information and product samples:
800.551.0121, mail@fischerconnectors.com,
www.fischerconnectors.com

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SPECIAL FEATURE: EMERGING TECHNOLOGIES

Unearthing New Opportunities on the Nanoscale

Daniel Grace

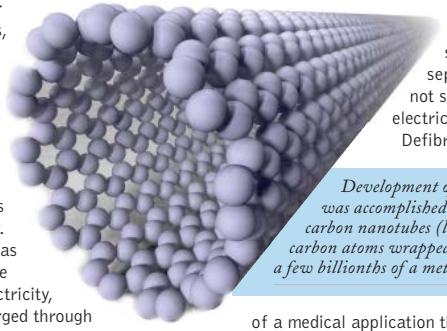
By 2014, $2.6 trillion in global manufactured goods, or about 15% of total global output, will incorporate nanotechnology, according to the independent advisory firm **Lux Research** (New York City; www.luxresearchinc.com). One of the areas where the continued growth will be most apparent is in the healthcare sector. Nanotechnology research with implications for the medical device industry is progressing rapidly, and academic institutions and medical device firms continue to make strides in bridging the gap between research and commercialization. The University of California at Los Angeles has announced the launch of the **California NanoSystems Institute** (Los Angeles; www.cnsi.ucla.edu), created with the expressed purpose of fostering partnerships between industry and university researchers. Elsewhere in the world, a recently formed company in the United Kingdom, **NanoCentral** (www.nanocentral.eu), offers to advise and assist companies in implementing nanotechnology equipment and services within existing business models.

In this feature, *MPMN* reports on several advancements in nanotechnology that have the potential to revolutionize medical product manufacturing in the years ahead. The innovations covered could have applications as varied as drug delivery, power supply, implantable device components, diagnosis, and detection.

Nanotubes Enable Development of Paper-Thin Battery

Toss a paper airplane, and, for a few entertaining seconds, there is the illusion of flight. But in the not-so-distant future, flying paper could cease to be illusory, thanks to a new electrical component made almost entirely of paper. The component can function as a battery, a supercapacitor, or a hybrid of both. Researchers anticipate a wide variety of applications for the component, including a number of novel possibilities related to medical devices, according to findings published in the August 13 issue of the *Proceedings of the National Academy of Sciences.*

Development of the component entailed infusing paper with carbon nanotubes, which consist of carbon atoms wrapped in tubes that measure only a few billionths of a meter. Cellulose—the plant seeds used in most kinds of paper—makes up 90% of the battery. The carbon atoms act as electrodes, allowing the battery to conduct electricity, and the battery is charged through contact with electrolytes. "We're not putting pieces together—it's a single, integrated device," says Robert Linhardt, professor of biocatalysis and metabolic engineering at the **Rensselaer Polytechnic Institute** (Troy, NY) and member of the research team. "The components are molecularly attached to each other. The carbon nanotube print is embedded in the paper, and the electrolyte is soaked into the paper. The end result is a device that looks, feels, and weighs the same as paper."



Development of a paper-thin battery was accomplished by infusing paper with carbon nanotubes (left), which consist of carbon atoms wrapped in tubes that measure a few billionths of a meter.

Lindhardt says the battery could also be powered through naturally occurring electrolytes, including those found in sweat, urine, and blood. The availability of batteries that can be charged by body fluids could stand to benefit the next generation of medical implants. Pacemakers are an example of implantable devices that both run on battery power and require an invasive procedure to change the battery. In the future, says Lindhardt, a pacemaker incorporating the paper-thin battery could charge itself inside of the human body simply by coming in contact with blood. The component's ability to work within a wide temperature range—up to 150°C—coupled with the nontoxic nature of paper, further establish the component as a viable option for future implantable devices.

Due to its size—approximately that of a postage stamp—the component may retain significant advantages over batteries used in current implantable devices, even in cases in which recharging must occur outside of the body. "A battery this size would only need to go just below the surface of the skin to be installed into an implantable device," says Lindhardt. "This could reduce the invasiveness of the procedure for replacing batteries."

In most electrical systems, batteries and supercapacitors are separate components—not so with the paper-thin electrical component. Defibrillators are an example of a medical application that would involve using the component as a supercapacitor. Today, defibrillators are bulky machines comprised of multiple components (including a supercapacitor), and defibrillation requires assistance by healthcare administrators. In the future, the entire unit could be something people carry in their pockets, and in case of emergency, use themselves.

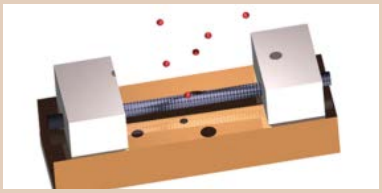
"The entire defibrillator could be the size of a piece of paper," Lindhardt explains. "You would take it out, unfold it, lay it on the patient's chest, and the paper-thin supercapacitor would use its stored electrical energy to release a short, powerful burst in order to resuscitate the heart."

Commercialization of the component may not be on the immediate horizon, but the research team has already turned its attention to the main impediment to achieving this goal. "We need a way to inexpensively mass-produce it," Lindhardt says. "Once we get it down, we'll have the ability to actually print batteries and supercapacitors using a roll-to-roll system similar to how newspapers are printed."

Rensselaer Polytechnic Institute
TROY, NY
www.rpi.edu

Sensor Could Provide Forewarning of Asthma Attacks

A recently developed nanotube sensor is reactive to minute amounts of nitric oxide, a gas prevalent in the breath of asthmatics, according to **University of Pittsburgh** (Pittsburgh, PA) professors who developed the sensor. If fitted in a handheld device, the tiny component could allow users to remove the element of surprise from asthma attacks. In addition to detecting attacks early on, a device incorporating the sensor could provide a portable method for patients and their doctors to regularly monitor their symptoms and tailor treatment accordingly.



A sensor reacts to minute amounts of nitric oxide, a gas prevalent in the breath of asthmatics.

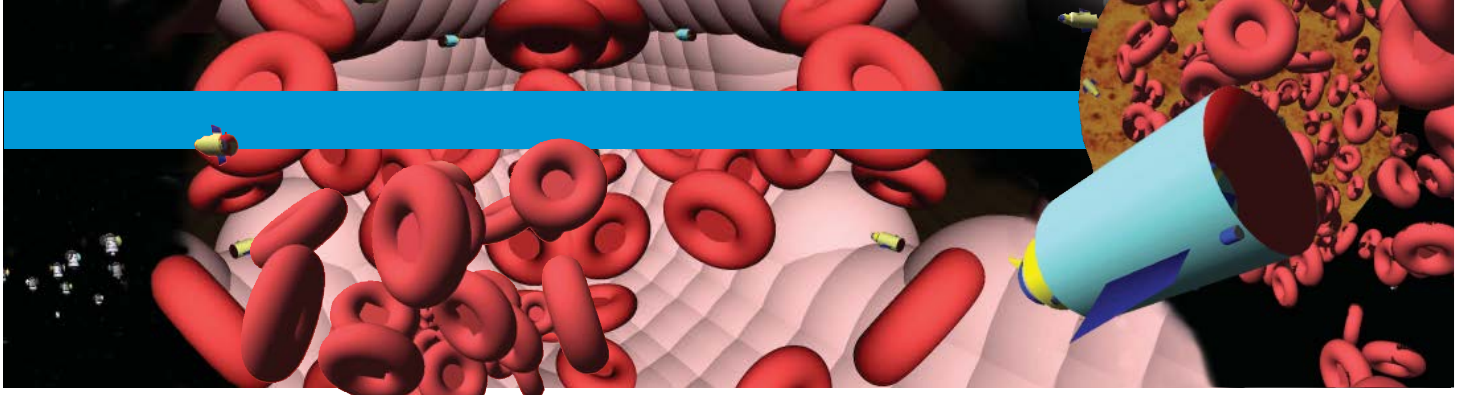
The sensor consists of a carbon nanotube, a sheet of graphite 100,000 times smaller than a human hair, and a coating made of a polyethylene imine polymer. Still in the early stages of development, the sensor could eventually offer unprecedented access to critical information when deployed in respiratory and biodetection devices. "The extreme thinness of nanotubes renders them extremely sensitive to small changes in their chemical environment," says Alexander Star, the project's lead researcher. "This quality makes nanotubes ideal for detection applications."

The sensor theoretically would be cased in a handheld device that asthmatics blow into to determine the nitric oxide content of their breath. Gas levels spike as airways grow inflamed, a symptom of an impending asthma attack. High levels of nitric oxide—up to two-thirds more than normal—may precede an attack by up to three weeks, possibly earlier, depending on the asthma's severity, according to Star.

Other advantages of the sensor include low power consumption and cost. "Although the design of the sensor is very sophisticated, the cost of carbon nanotubes can be quite inexpensive," Star says. "And the handheld devices would be much less expensive than the bulky machines used today to detect nitric oxide levels."

Because of their expense, current nitric oxide detecting machines are only available in outpatient clinics, making them suitable for diagnosis and for gauging the severity of asthma, but impractical for monitoring symptoms. A handheld device incorporating the sensor would be ideal for self-monitoring, says Star. "This invention could allow people with asthma to watch their nitric oxide levels as easily as people with diabetes check their blood sugar with handheld glucose monitors."

University of Pittsburgh
PITTSBURGH, PA
www.pitt.edu



Nanostructures Get in Shape for Drug Delivery

Block copolymers can be found in rubber soles for shoes, and, more recently, in portable memory sticks (flash drives) for computers. Soon, the material might be found in the human body as well. Researchers have discovered how to make synthetic polymer molecules assemble and form into long cylinders, a nanostructure potentially suited for drug-delivery applications. The finding was first reported in the August issue of *Science* by a research team lead by Darrin Pochan, associate professor at the **University of Delaware** (Newark, DE), and Karen Wooley, professor at **Washington University** (St. Louis).

"A block copolymer is a long-chain molecule, a length of which, or block, is chemically different than the other," says Pochan. "So, you put them in a solution where one of the blocks repels and tries to get away and the other doesn't, which is how you get different shapes to form."

The scientists used a tri-block copolymer composed of polyacrylic acid, polymethylacrylate, and polystyrene. They introduced it to a solution of tetrahydrofuran and water, as well as organic diamines. The technique relied on divalent organic counter ions and solvent mixtures to drive the organization of the block copolymers down specific pathways into long, one-dimensional structures.

In the past, self-assembly on the nanoscale has typically produced simple shapes, such as spheres, which present problems for drug delivery. "If you put little balls full of a drug into the bloodstream, the body's organs and immune system will clear it out in a day," Pochan says. "But, if you place the molecules into long, floppy cylinders, they may stay in the body for weeks."

Floppy cylinder nanostructures can also be formed to provide multiple compartments (unlike a sphere, which is capable of providing only one compartment)—another potential advantage for drug delivery. Multicompartmental structures suggest intriguing possibilities, says Pochan, including devices that could store different drugs in separate compartments, thereby enabling a single device to deliver an entire drug regimen.

In addition to new shapes, the research has also yielded a bottom-up approach for building nanostructures. "Bottom-up manufacturing has gotten a bad rap in recent years, but this research has made it relevant for nanomanufacturing," Pochan says. "Rather than design a large structure or component and use lithography to form it into what you want, our goal is to design a molecule with all the information it needs built-in, and then you throw it in water and it zips up into the desired complex shape and size."

Researchers have discovered how to make synthetic polymer molecules form into long cylinders, a nanostructure potentially suited for drug-delivery applications.

"It's all about constructing materials and nanostructures in an easy way," he adds.

University of Delaware
NEWARK, DE
www.udel.edu

Washington University
ST. LOUIS, MO
www.wustl.edu

Emerging Challenges

Nano Surveys Serve Disconnection Notices

Firms commercializing nanotechnology lack a clear procedural roadmap for navigating governmental environmental, health, and safety (EHS) standards, according to a new survey conducted by the **Project on Emerging Nanotechnologies** (www.nanotechproject.org). Many firms also lack the necessary information to meet regulatory expectations.

The report is drawn from an online survey distributed to 180 managers from firms in the Northeast, and its results are consistent with surveys of companies in California, New York, and around the world, say the report's authors John Lindberg and Margaret Quinn, professors at the **University of Massachusetts–Lowell** (Lowell, MA; www.uml.edu).

Lindberg and Quinn found that 80% of large firms were taking steps to manage nanotechnology EHS risks, compared with 33% of small and microcompanies, and 12% of firms at the start-up stage. "Many smaller firms recognize the need to address risks, but few have the resources to do so," Lindberg says.

Quinn adds, "Firms are flying somewhat blind into the future and need a clear set of rules, a sense of the emerging regulatory landscape, and access to relevant research on risks in order to ensure both nanotechnology safety and profits."

Another recent study describes a nanotechnology-related communication gap of a different kind: between scientists and the public. "Nanotechnology is starting to emerge on the policy agenda, but it's not on [the public's] radar," says Dietram Scheufele of the **University of Wisconsin–Madison** (Madison, WI; www.wisc.edu), coauthor of the study.

"In the long run, this information disconnect could undermine public support for federal funding in certain areas of nanotechnology research," says the survey's coauthor, Elizabeth Corley of **Arizona State University** (Tempe, AZ; www.asu.edu).

"As citizens are faced with decisions about federal funding guidelines, one would hope that they could make these decisions with as much information about the science behind these proposals as possible," Scheufele adds.

The survey's findings were based on a national telephone survey of 363 American nanotechnology scientists and engineers, along with a telephone poll of average citizens. The authors found that scientists were both more optimistic and less concerned than the public about most nanotechnology-related risks.

Software Provides Peek into the Body—and the Future

Actual in-body nanorobots for the purposes of diagnosing and treating harmful conditions on the cellular level are years away. For now, scientists can only imagine. Nanorobot prototyping software, however, may allow researchers to use their imaginations in more sophisticated ways.

The nanorobot control design (NCD) software is a system designed to serve as a test bed for nanorobot 3-D prototyping. The findings were first published in the January issue of *Nanotechnology* by a group of Australian and American researchers.

The NCD platform combines 3-D modeling and virtual reality to enable the design, simulation, and testing of nanorobots. In a real-time simulation demonstration, virtual nanorobots were assigned the task of searching for proteins in a dynamic environment, and bringing those proteins to a specific organ inlet for drug delivery.

Simulation using 3-D modeling can provide interactive tools for analyzing nanorobot design choices, including decisions related to sensors, architectural design, manufacturing, and control methodology. Specifically, NCD lets nanorobots operate inside of a virtual human body in order to compare control techniques.

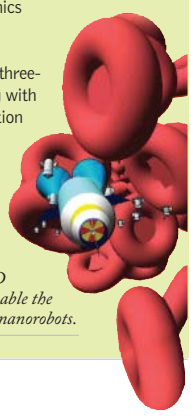
Eventually, designers will be able to use the NCD platform for actual nanorobot design prototyping for specific applications, says Adriano Cavalcanti, CEO of the **Center for Automation in Nanobiotech** (Melbourne, Australia), a private company that focuses on developing systems and prototypes related to nanotechnology in the medical device sector.

"The numerical and advanced simulations provided a better understanding of how nanorobots should interact and be controlled inside the human body; hence, based on such information, we have proposed innovative hardware architecture with a nanorobot model for use in common medical applications," Cavalcanti says. "The proposed platform should enable virtual patient pervasive monitoring, as well as precise diagnosis and smart drug delivery for cancer therapy."

"In the same way microelectronics provided new medical devices in the 1980s, now miniaturization through nanotechnology is enabling the manufacture of nanobiosensors and actuators to improve cell biology interfaces and biomolecular manipulation." Fully operational nanorobots for biomedical instrumentation should be achieved as a result of nanobioelectronics and proteomics integration, Cavalcanti says.

Cavalcanti says achieving the goal of functional, feasible nanorobots will be a three-step process. First, model manufacturing with carbon nanotube-CMOS biochip integration will have to occur, followed by in vivo tests, and, finally, commercialization.

Center for Automation in Nanobiotech (CAN)
MELBOURNE, AUSTRALIA
www.canbiotechnems.com



A software platform combines 3-D modeling and virtual reality to enable the design, simulation, and testing of nanorobots.

BREAKTHROUGHS

GPS-Inspired System Enables Real-Time Positioning of Devices

The release of global positioning system (GPS) capabilities for automobiles has aided countless drivers in plotting a clear course to their destination, removing the uncertainty and frustration associated with getting lost. A GPS-inspired technology applied to medical devices could yield the same results.

Medical Positioning System (MPS) technology, developed by Israel-based medical device company **MediGuide Ltd.**, is designed to help physicians navigate devices through the tortuous environment of the body. MPS provides real-time position and orientation information projected in a 2- or 3-D image on either live fluoroscopic or recorded backgrounds.

"Nothing [is on the market] with the same accuracy, physical sensor dimension, level of integration with imaging, and compensation for moving organs," says Allon Guez, vice president of business development.

MPS-equipped sensors can be integrated into the tips of such devices as guidewires, catheters, stents, and balloons. Using proprietary electromagnetic technology, MPS technology enables tracking of the sub-millimeter-sized sensors within a magnetic field created by the MPS unit's field generator. It draws from non-line-of-sight intrabody navigation methods; however, it is not limited by the drawbacks commonly associated with the technique, according to MediGuide. The company points to such disadvantages of the existing navigation technique as the need to maintain a continuous line of sight between the tracking cameras and visual designators on the device, and the inability to track nonrigid devices.

Catheters could soon feature medical positioning system technology, which would provide real-time position and orientation information for intrabody navigation.

"MPS currently brings a better 3-D perspective to the physicians and facilitates ease of use and accuracy in the navigation of devices," Guez says. "Once additional claims are clinically approved, it is also expected to reduce exposure to radiation and use of toxic dye, as well as to improve procedure flow."

The technology recently received the CE mark for use in Europe, as did the first MPS-enabled guided measurement catheter, which can be used with conventional x-ray angioplasty systems featuring MPS, according to the company. In addition to positioning details, the system also provides quantitative length measurement, 3-D lumen construction, qualitative 3-D foreshortening indication, and landmarking.

Despite European consent, MPS and associated MPS-enabled products are not yet approved for use in the United States. FDA sanctioning could be on the horizon, however. Furthermore, in January, MediGuide signed a collaboration agreement with Medtronic for the development of MPS-enabled products in North America.

MediGuide Ltd.
HAIFA, ISRAEL
www.mediguide.co.il

Supplier Turns Pollutants into Plastic

Green manufacturing trends have driven engineers to take seemingly far-fetched notions of making plastic out of any crop or waste material and turn those ideas into practical realities. **Novomer Inc.** is one such company, customizing performance characteristics of its ecofriendly plastics, which are made with waste products like carbon dioxide.

Developed by Geoffrey Coates, the company's cofounder and chief scientific officer, along with his research group at Cornell University, the plastics-making process uses catalysts to create polymers whose source materials contain 30 to 50 % carbon monoxide and carbon dioxide. This technology can significantly reduce the amount of petroleum products and fossil fuels typically required for manufacturing polymers, according to Novomer president Charles Hamilton.

A carbon dioxide–based polymer (pictured above in resin form) has the consistency and viscosity of honey.

Novomer bonds liquid epoxies with carbon dioxide in a reactor similar to a pressure cooker with the help of a catalyst, such as beta-diiminate zinc acetate. The catalyst material is then filtered out of the honey-like liquid after it is removed from the reactor. Because the process is based on synthetic chemisty, Novomer has a great amount of control and flexibility in manufacturing the materials.

"The ability to use synthetic chemistry to make these materials allows us to provide very high quality control and custom performance characteristics—such as heat resistance and time to reabsorption," says Hamilton. "Device makers can work together with Novomer to specify precise performance characteristics for medical polymers. We're not limited by the narrow window of customization that biologically derived polymers are limited to."

Making polymers based on biological materials has been possible for some time; however, the concept was considered somewhat of a novelty because the high manufacturing cost discouraged large-scale production, according to the company. Its process not only reduces that cost, but also gives the firm more control over the composition of the materials

"We have the option of making biodegradable materials or more-enduring materials, depending on the need," says Hamilton. "We can make a variety of high-performing bioabsorbable custom materials, such as high-melt-point PLA, high-performance PHA, and bioreabsorbable polymers, from carbon dioxide," he says. The green materials can be made to deliver drugs slowly over time or for bioreabsorbable applications, like implants, stents, or orthopedic devices.

"There are many players, large and small, working on new green polymers," says Hamilton. "What sets Novomer apart is our ability to very precisely control simple building blocks like carbon dioxide and epoxies using catalytic chemistry to make high-performance materials."

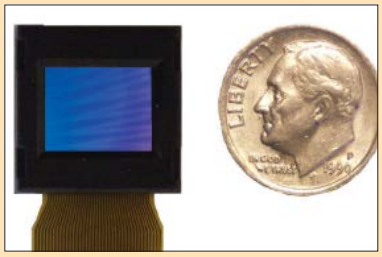
— Stephanie Steward

Novomer Inc.
ITHACA, NY
www.novomer.com

Company Debuts World's Smallest Color SVGA Display

By incorporating single-crystal silicon transistors, **Kopin Corp.** has developed what it claims is the world's smallest color SVGA display. The CyberDisplay SVGA LVS measures 0.44 in. diagonal—the same size at the company's current VGA display—but with a higher resolution of 640 × 480 pixels. Endoscopic and vision-aid systems are among the display's potential medical applications.

The display uses the same design architecture as large LCDs, but with a pixel size of 11.25 µm square—1000 times smaller than the pixels used by flat-screen televisions. Single-crystal silicon transistor technology, as contrasted with the polysilicon transistor technology used in such everyday small displays as cell phones, provides high pixel density, allowing for sharp color images despite the small pixel size. A planar multimetal layering process, a nanotechnology process for liquid-crystal alignment, and a cell-gap liquid-crystal assembly process further enabled development.



The CyberDisplay SVGA LVS features a pixel size of 11.25 µm square—1000 times smaller than the pixels used by flat-screen televisions.

Previously, the company's smallest color SVGA display had been 0.59 in. diagonal. Power consumption has also been reduced compared with the company's previous small SVGA model, down to 70 mW from 100 mW. Low power consumption is essential with a display of this size, notes Hong Choi, chief technical officer. "A display this small is designed to be optically magnified by an eyewear device in order for the image to be vivid," he says. "For such a device to be practical, it must be battery operated, so the display can't consume very much power."

A device incorporating the display would function similarly to a microscope, with the user looking through a lens that enlarges the subject—the subject in this case being the display. Such a device could be incorporated in endoscopic systems, according to Choi. "In today's systems, the image from inside the body is displayed on a monitor that the surgeon must occasionally glance up to, and continuously glancing up and down takes up time and also increases the chance for error," Choi says. "A high-resolution eyewear device would allow the surgeon to see clear, detailed images inside of the body without having to move his head." Choi adds that the display's small size would enable such a device to be light and unobtrusive, allowing the surgeon to simply shift his or her eyeline below the device (like with a pair of spectacles) in order to see the operating field in plain view.

In the past, Kopin's products have been used primarily in the consumer and military markets, but the company is aiming to increase its presence in the medical device sector, according to Choi. *–Daniel Grace*

Kopin Corp.
WESTBORO, MASSACHUSETTS
www.kopin.com

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