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Industry Updates

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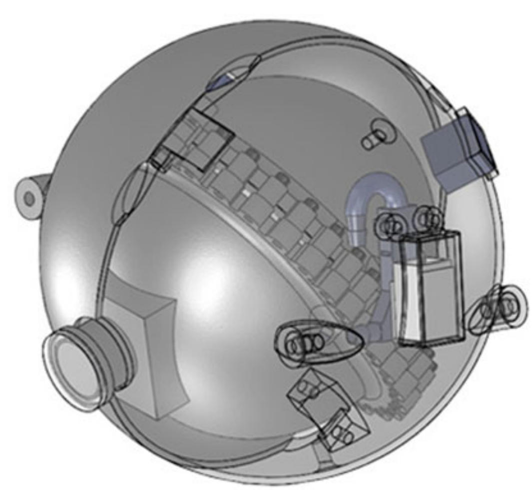
Tiny Robots Could Monitor Underground Reactor Pipes

As workers continue to grapple with the damaged Fukushima Daiichi nuclear power plant in Japan, the crisis has shone a spotlight on nuclear reactors around the world. Harry Asada, the Ford Professor of Engineering in the Department of Mechanical Engineering and director of MIT's d'Arbeloff Laboratory for Information Systems and Technology, says one of the major challenges for safety inspectors is identifying corrosion in the underground pipes of a reactor. Currently, plant inspectors use indirect methods to monitor buried piping: generating a voltage gradient to identify areas where pipe coatings may have corroded, and using ultrasonic waves to screen lengths of pipe for cracks. The only direct monitoring requires digging out the pipes and visually inspecting them—a costly and time-intensive operation.

Asada and his colleagues at the d'Arbeloff Laboratory are working on a direct monitoring alternative: small, egg-sized robots designed to dive into nuclear reactors and swim through underground pipes, checking for signs of corrosion. The underwater patrollers, equipped with cameras, are able to withstand the extreme, radioactive environment, transmitting images in real-time from within the reactor. The robot is the shape of a smooth sphere with a propulsion system that can harness the considerable force of water rushing through a reactor. The group devised a special valve for switching the direction of a flow with a tiny change in pressure and embedded a network of the Y-shaped valves within the hull, or "skin," of the robot, using 3D printing to construct the network of valves, layer by layer. Asada envisions the robots as short-term, disposable patrollers, able to inspect pipes for several missions before breaking down from repeated radiation exposure. The group presented details of its latest prototype at the 2011 IEEE International Conference on Robotics and Automation.

For more information: d'Arbeloff Laboratory for Information Systems and Technology, Massachusetts Institute of Technology, Department of Mechanical Engineering, 77 Massachusetts Avenue, Room 1-007, Cambridge, MA 012139; tel: 617/258-0811; e-mail: dlab@mit.edu; web: http://darbelofflab.mit.edu/.



A spherical robot equipped with a camera may navigate underground pipes of a nuclear reactor by propelling itself with an internal network of valves and pumps. Photo courtesy of Harry Asada/d'Arbeloff Laboratory

Superelastic Alloy Produces Corrosion-Immune, Shockproof Bearings

Many aerospace bearing and mechanism failures can be traced back to the intrinsic inadequacy of currently available materials. Bearing race denting is a particularly troublesome problem for spacecraft applications where high vibrations during launch can lead to bearing damage. As a result, engineering designs often include extra safety margins or heavy and cumbersome vibration isolation systems to prevent damage. To address these issues, the NASA Engineering and Safety Center (NESC) is supporting the effort to assess an emerging intermetallic alloy, NiTiNOL 60 (60NiTi), for use in shockproof, corrosion-immune bearings. Because it contains no iron and cannot rust, 60NiTi is highly resistant to corrosion. Further, it belongs to the family of "superelastic" materials and exhibits the uncanny ability to withstand tremendous loads and stresses without permanent deformation (i.e., denting).

Recent experiments sought to compare the dent resistance of 60NiTi to other bearing materials by pressing ceramic (Si_3N_4) or hardened 60NiTi balls into flat plate specimens made from conventional bearing race materials. Depending on the specific material combination, the use of 60NiTi increased dent resistance by a factor of approximately 5–50. In addition, tests have confirmed that corrosion behavior of 60NiTi exceeds that of the best corrosion-resistant materials, the cobalt-base superalloys. When hard balls are pressed into flat plates of various bearing race materials, the superelastic 60NiTi can withstand the highest loads. This suggests it will make a dent-resistant bearing with excellent corrosion resistance.

For more information: A NASA Technical Memorandum, "Resilient and Corrosion-Proof Rolling Element Bearings Made from Superelastic Ni-Ti Alloys for Aerospace Mechanism Applications," is available to the public at www.sti.nasa.gov or by contacting NASA Center for Aerospace Information, 7115 Standard Drive, Hanover, MD 21076-1320.

Bearing balls made from 60NiTi. They are highly corrosion resistant and resist denting because they are within the rare class of "superelastic" materials

Train Vibrations Provide Power for Tunnel Monitors

Martin Wischke and fellow researchers from the University of Freiburg in Germany are developing a power unit that harvests the vibrations from passing traffic to power the wireless sensor nodes of a structural health monitoring system for tunnels. The power harvesting unit could reduce maintenance costs and improve the performance of the sensor network. The study is part of the AISIS project funded by the Federal Ministry of Education and Research and has been published in a recent issue of *Smart Materials and Structures.*

The researchers designed, fabricated, and tested a piezoelectric vibration harvester capable of harvesting vibrations across a broad frequency, because each train produces a slightly different frequency spectrum. The energy is then stored in a capacitor and supplied to the sensor system when needed. In order to ensure safe handling of the harvested energy, the researchers designed an ultralow-power control circuit that monitors the storage capacitor voltage and disconnects the sensor circuit from the capacitor if not enough energy is available. The researchers plan to expand the harvested frequency spectrum and increase the power output, and then prepare the system for industrial applications. In addition to energy harvesting, the system could be used in railway traffic surveillance, because details about the passing train (such as the quality of the wagon wheels and wagon weight) can be derived from the vibrations.

For more information: M. Wischke, et al.: "Vibration harvesting in traffic tunnels to power wireless sensor nodes." *Smart Mater. Struct.,* **20**(8), 2011; http://iopscience.iop.org/0964-1726/20/8/085014?fromSearchPage=true.

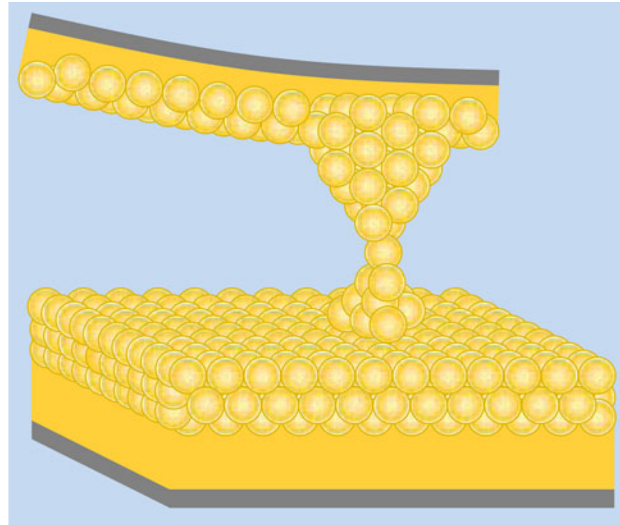
Nanoscale Thermal-Mechanical Treatment Improves Fatigue Resistance for Medical Implant Wires

Fort Wayne Metals has developed a thermal-mechanical treatment for increasing the damage tolerance of small-diameter wire during high-cycle mechanical loading. Called NDR (nanograin damage resistant) technology, it produces nanoscale microstructural refinement that improves fatigue resistance of wires in medical implant devices. "While our results may not translate into every application, we have observed improvements in the rotary beam fatigue strength of up to 83% in 0.007 in. diameter ASTM F562 wire during our testing," says Jeremy Schaffer, Senior Research and Development Engineer. "By leveraging microstructural mechanisms through significant refinement of the grain size in NDR wire, we can increase fatigue strength without changing the chemical makeup of the alloy. And we can do it without significant impact to other wire properties, such as corrosion resistance."

The NDR process may be applied to non-precipitation-hardening, non-sensitizing, implant-grade alloys such as ASTM F562 alloy (35 N LT wire or MP35 N wire), ASTM F1058 (FWM 1058 wire), and ASTM F138 (316LVM). The processing does not change the chemical or atomic makeup of the alloy. Properties such as density, electrical resistivity, thermal conductivity, and thermal coefficient of expansion are similar before and after the application of NDR technology. The performance of NDR wire is attributable to the underlying microstructure. Grain size of conventional alloy microstructure is two micrometers.

For more information: Fort Wayne Metals, 9609 Ardmore Avenue, Fort Wayne, IN 46809; web: www.fwmetals.com/NDR.php.

Narrowest Bridges of Gold are also Strongest



A bridge made of a single atom of gold has twice the strength of bulk gold, according to new research. Image courtesy of University of Buffalo

As engineers look to build devices such as computer circuits with ever-smaller parts, it is critical to learn more about how tiny components comprising a single atom or a few atoms might behave, because physical properties of atomic-scale gadgets differ from those of larger "bulk" counterparts. At an atomic scale, the tiniest bridge of gold—that made of a single atom—is actually the strongest, according to research by engineers at the University at Buffalo's Laboratory for Quantum Devices. The counter-intuitive finding is the result of experiments probing the characteristics of atomic-scale necks of gold that formed when the pointed gold tip of a cantilever was pushed into a flat gold surface. An examination of these tiny gold bridges revealed that they were stiffest when they comprised just a single atom.

"Everyday intuition would suggest that devices made of just a few atoms would be highly susceptible to mechanical forces," the team said. "This study finds, however, that the ability of the material to resist elastic deformation actually increases with decreasing size." Another observation the team made while studying the tiny gold necks: abrupt atomic displacements that occur as the gold tip and surface are drawn apart are not arbitrary, but follow well-defined rules of crystallography. The study was published in June in *Physical Review B* by a trio of researchers from the university's Department of Mechanical and Aerospace Engineering: postdoctoral fellow Jason Armstrong and professors Susan Hua and Harsh Deep Chopra. Support for the work came from National Science Foundation grants.

For more information: The University at Buffalo, Department of Mechanical and Aerospace Engineering, 318 Jarvis Hall, Buffalo, NY 14260-4400; tel: 716/645-2593; web: www.mae.buffalo.edu.

Antibacterial Stainless Steel Resists Wear

Materials scientists at the University of Birmingham, UK, have made stainless steel surfaces resistant to bacteria by introducing silver or copper into the top layers of the surface. Hanshan Dong, Professor of Surface Engineering and lead investigator, said, "Previous attempts to make stainless steel resistant to bacteria have not been successful as these have involved coatings which are too soft and not hard-wearing." The modified surface, as opposed to a coating, is resistant to wear and tear during cleaning.

The team developed the surface alloying technology using Active Screen Plasma (ASP) with a purpose designed composite or hybrid metal screen. The combined sputtering, back-deposition, and diffusion allow the introduction of silver into a stainless steel surface, along with nitrogen and carbon. The silver acts as the bacteria-killing agent and the nitrogen and carbon make the stainless steel much harder and durable. The researchers replicated the cleaning process for medical instruments in hospitals. After cleaning the treated instruments 120 times they found that the antibacterial properties of the stainless steel were still intact and the surface still resistant to wear. Professor Dong's team is confident that this technique could be used in the manufacturing of stainless steel products, because they are already able to surface engineer items of up to 2 × 2 meters in the laboratory.

For more information: School of Metallurgy and Materials, University of Birmingham, Edgbaston, Birmingham B15 2TT, UK; tel: (+44) (0)121 414 5222; fax: (+44) (0)121 414 7468; e-mail: J.Henderson@bham.ac.uk; web: www.birmingham.ac.uk.

Molds for High-Strength Steel Sheet Last Four Times Longer with TiCr Coating

Nippon Koshuha Steel, a unit of Kobe Steel, Japan, has developed a surface treatment process that improves by a factor of four or five the durability of the molds that press high-strength steel sheet for the auto industry. The surface of the mold is coated with a mixture of titanium and chromium compounds and is heated at a temperature of 450 °C (840 °F). The resulting film is only ten microns thick, but reduces wear of the molds in contact with high-strength steels.

Molds wear down on the assembly line because of heat and impact with the steel sheets. The problem has become worse as automakers shift to higher-strength steel to reduce weight and increase safety. Improved durability can help automakers boost productivity because they do not need to stop production as often to replace the molds. The reformulated coating helps the mold better withstand contact with high-strength steel, and because it is baked at a lower temperature, there is less chance that the mold could warp during processing. Several automakers have already decided to use the technology, including Toyota and Hino Motors.

For more information: Nippon Koshuha Steel Co. Ltd., 8F TMM Building, 1-10-5 Iwamoto-cho, Chiyoda-ku, Tokyo, 101-0032 Japan; tel: +81-3-5687-6023; fax: +81-3-5687-6047; web: www.koshuha.co.jp/corporate/pdf/co_guide_eng.pdf.

Coatings Show Promise as Flame Retardants in Polyurethane Foam

Ignition of soft furnishings account for approximately 5% of residential fires, and the consequences are disproportionately high. These fires are responsible for a third of fire-caused deaths of civilians and 11% of property losses due to fires in homes. The flammability of mattresses is regulated by federal law. A complementary rule to regulate the flammability of upholstered furniture has been proposed recently. Several organizations, however, challenged the health and safety of some flame retardants designed to protect against soft furnishing fires.

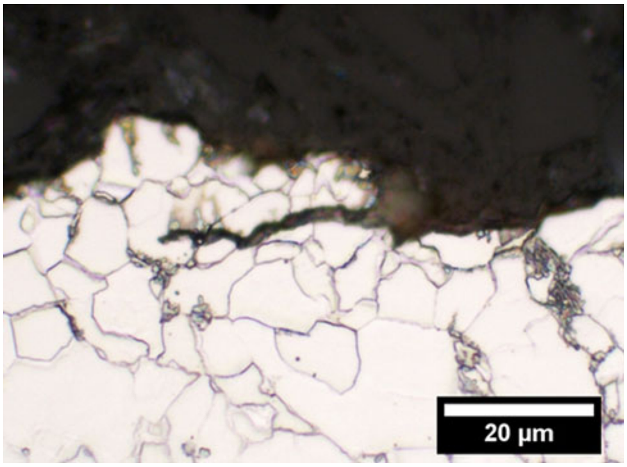
Today, recipes for making polyurethane foams (PUFs) result in foams in which fire retardants are embedded in the interior. In contrast, researchers from the National Institute of Standards and Technology (NIST) and Texas A&M University have used a carbon nanofiber-filled fire retardant as a coating that covers all the nooks and crannies on the spongelike PUF surface. The experimental coating, according to NIST researcher Rick Davis, seems to create the equivalent of a "fire-resistant armor" on the porous foam. Gram for gram, the coatings outperformed conventional flame retardants used in the polyurethane foam of upholstered furniture and mattresses by at least 160% and perhaps by as much as 1130%. This approach, says Davis, should be attractive to manufacturers because the surface treatment has the potential to deliver low flammability without major change to the foam manufacturing process, thus saving time and money.

For more information: National Institute of Standards and Technology, 100 Bureau Drive, Stop 1070, Gaithersburg, MD 20899-1070; tel: 301/975-NIST (6478); e-mail: inquiries@nist.gov; web: www.nist.gov.

Ethanol-Loving Bacteria Accelerate Cracking of Pipeline Steels

Production of ethanol for fuel has been rising quickly in the U.S., topping 13 billion gallons in 2010. With the usual rail, truck, and barge transport methods under potential strain, existing gas pipelines might be an efficient alternative for moving this renewable fuel around the country. But researchers at the National Institute of Standards and Technology (NIST) caution that ethanol, and especially the bacteria sometimes found in it, can dramatically degrade pipelines. Researchers at NIST presented experimental evidence that bacteria that feed on ethanol and produce acid boosted fatigue crack growth rates by at least 25 times the levels occurring in air alone.

The team used a new biofuels test facility to evaluate fatigue-related cracking in two common pipeline steels immersed in ethanol mixtures, including simulated fuel-grade ethanol and an ethanol-water solution containing common bacteria, *Acetobacter aceti.* Ethanol and bacteria are known to cause corrosion, but this is the first study of their effects on fatigue cracking of pipeline steels. Material samples were installed in hydraulic test frames and subjected to load cycles while immersed in fuel inside a transparent polymer tank. Fatigue crack growth and other properties were observed over a period of up to ten days. Preliminary tests also suggested that glutaraldehyde, a biocide used in oil and gas operations, may help control bacterial growth during ethanol transport. The staff expect



Micrograph of crack in X52 steel after the sample was subjected to mechanical forces for several days in an ethanol solution containing acid-producing bacteria. Image courtesy of Sowards/NIST

to continue and possibly expand the research to other potential biofuels such as butanol or biodiesel.

For more information: National Institute of Standards and Technology, 100 Bureau Drive, Stop 1070, Gaithersburg, MD 20899-1070; tel: 301/975-NIST (6478); e-mail: inquiries@nist.gov; web: www.nist.gov.

Researchers Work to Extend Battery Life

At the U.S. Department of Energy's (DOE) Argonne National Laboratory, materials scientist Daniel Abraham and his colleagues are working to extend the life of lithium-ion batteries for cell phones, laptops, and the next generation of plug-in hybrid or all-electric cars. "The arrangement of atoms within the crystal structure plays a role in how the battery performs," Abraham explains. "What we are doing now is looking at batteries in situ: that is, actually watching the battery as it charges and drains, using powerful x-rays from the Advanced Photon Source and electrons from the Electron Microscopy Center. That's the cutting edge of battery diagnostics." A combination of methods allows researchers to examine every angle. For example, microscopy methods help the team decipher the architecture and composition of battery components, while x-ray techniques allow them to decode the arrangement of individual atoms.

Modifying the elemental composition and size of cathode particles can improve energy and power; a pre-made protective layer on graphite can reduce corrosion; altering electrolyte chemistry can make the cell more heat tolerant; better manufacturing practices can reduce the incidence of electrical shorts. New battery designs are tested with accelerated aging methods to determine long-term performance. "In cell phones, you can get away with a battery that lasts only a couple of years," Abraham said. "For vehicles, you need a battery that lasts 10-15 years, which is the typical lifetime of a car." Battery testers charge and drain the cells over and over again at elevated temperatures; the test conditions are carefully chosen to mimic the effect of years of use. Using this method, scientists can cycle through testing, diagnostics, and chemistry modifications, changing and re-testing generations of batteries in just a few years.

For more information: Argonne National Laboratory, 9700 S. Cass Avenue, Argonne, IL 60439; tel: 630/252-2000; web: www.anl.gov.

Honda Recalls 50,000 Vehicles

Honda Motor Co. in Tokyo has recalled a combined 50,122 units in the Stream minivan, the Civic sedan, and the Crossroad sport utility vehicle to repair bolts that fix the water pump pulley to the engine.

The bolts may lose tension or fracture, causing the drive belt that runs both the alternator and the water pump to circulate coolant water to come off the pulley. The engines of the vehicles, made between July 2008 and July 2010, may stall due to the defect. The automaker is also implementing a recall for the models in overseas markets, including Latin America and Europe, where a total of 150,000 units were marketed.

For more information: American Honda Motor Co., Inc., Honda Automobile Customer Service, 1919 Torrance Boulevard, Mail Stop: 500-2N-7D, Torrance, CA 90501-2746; tel: 800/999-1009; fax: 310/783-3023; web: www.ahm-ownerlink.com.

Sandia Battery Abuse Testing Laboratory Undergoes $4.2 Million Renovation

Sandia's Battery Abuse Testing Laboratory is undergoing a major renovation so Sandia researchers can test larger batteries for electric and plug-in hybrid electric vehicles. Built in 1991, the lab has facilitated thousands of critical scientific studies to evaluate the safety of batteries under every imaginable abuse scenario that a battery might face in the real world. Those studies included 12 years of testing for the FreedomCAR program and the U.S. Advanced Battery Consortium. The $4.2 million overhaul is part of a $104.7 million federal stimulus package whose goal is to advance national clean energy and technology efficiency across seven Department of Energy (DOE) national labs. The Battery Abuse Testing Lab's share is paying for much-needed upgrades to the lab, including updating test bays, data acquisition systems, and laboratory space, along with

Chris Orendorff, team lead for the Battery Abuse Testing Lab, looks over plans for the BATLab remodeling project. Photo courtesy of Randy Montoya

several new staff positions and approximately 50 construction-related jobs.

"This will bring our capabilities up to the point where we can test larger batteries that are going to be relevant to the electric vehicle market, and move up to batteries that will be used in plug-in hybrid electric vehicles," said Chris Orendorff, team lead for the Battery Abuse Testing Lab. "We'll have the capability to test batteries in the 5- to 15-kilowatt-hour range, which we've never done before. This scale of testing is critical to the deployment of electric vehicles that are needed to reduce the nation's dependence on foreign oil."

For more information: Sandia National Laboratories, www.sandia.gov.

Bridge Destruction to Reveal Clues about 'Fracture-Critical' Spans

In efforts to reduce the annual cost of inspecting large spans, a civil engineer at Purdue University is taking advantage of the demolition of a bridge spanning the Ohio River to learn more about how bridges collapse.

"There is a whole family of bridges called fracture-critical," said Robert J. Connor, an associate professor of civil engineering. "This means that if an important tension member breaks, it's thought the bridge will fall down." However, modern analysis techniques could be used to learn whether such bridges really are fracture-critical, or whether other structural elements would share the load if a major piece failed. "We are looking at 'after-fracture redundancy,' or whether a bridge does remain standing after a key element fails," Connor said. "If we could show they have redundancy, that a bridge won't collapse, more rational inspection strategies could be developed, allowing resources to be placed on the bridges that really should be inspected."

Approach span leading to the Milton-Madison Bridge in southern Indiana, which will be demolished in stages. Photo courtesy of Purdue School of Civil Engineering/Ryan Sherman

Connor and his team of research engineers and a student will purposely damage an approach span leading to the Milton-Madison Bridge in southern Indiana. The 82-year-old bridge, on U.S. Route 421 connecting Milton, Ky., and Madison, Ind., is being demolished in stages. Connor suggested piling a load of sand onto one of the approach spans to simulate the weight of trucks and then cutting a critical member of the bridge with an explosive charge. He took his idea to an engineering consultant, Michael Baker Corp., and general contractor Walsh Construction, as well as officials from the Federal Highway Administration and Indiana and Kentucky state transportation departments. The proposal was approved and federal funding provided. The 100-foot approach span has been fitted with 50 sensors; a portion of the span will be damaged and the findings recorded. The researchers will also record high-speed video.

For more information: Purdue University School of Civil Engineering, 550 Stadium Mall Drive, West Lafayette, IN 47907-2051; tel: 765/494-2166; fax: 765/494-0395; web: https://engineering.purdue.edu/CE. Broadcast-quality B-roll of Robert Connor's bridge researchers in action is available for download at ftp://news69.uns.purdue.edu/Public/ConnorBridges/.

Wireless Bridge Sensors Offer Instant, Affordable Warnings

Newer "smart" bridges have embedded wired networks of sensors, but University of Maryland electrical engineering researcher Mehdi Kalantari says the cost is too high for use on older spans. "A wired network approach will cost at least 100 times more than a wireless alternative, and that's simply unaffordable given the strain on local, state, and federal budgets," Kalantari estimates. He has created tiny wireless sensors that monitor and transmit minute-by-minute data on the structural integrity of a bridge. A central computer analyzes the data and instantly warns officials of possible trouble.

The sensors measure indicators of structural health, such as strain, vibration, flexibility, and development of metal cracks. The sensors are small, wireless, rugged, and require practically no maintenance, he says. They are expected to last more than a decade, with each costing approximately $20. An average-sized highway bridge would need about 500 sensors for a total cost of approximately $10,000. "The immediacy, low cost, low energy, and compact size add up to a revolution in bridge safety monitoring, providing a heightened level of early-warning capability," Kalantari concludes.

For more information: Resensys LLC, 387 Technology Dr., College Park, MD 20742; e-mail: info@resensys.com; web: www.resensys.com.

Computer Simulation Accurately Reconstructs Pipe Fractures

A computer model that tests automobile components for crashworthiness could also be of use to the oil and gas industry, according to researchers at MIT's Impact and Crashworthiness Laboratory who are now using their simulations of material deformation in car crashes to predict how pipes may fracture in offshore drilling accidents.

As a case study, the team simulated the forces involved in the 2010 Deepwater Horizon explosion in the Gulf of Mexico, finding that their model accurately predicted the location and propagation of cracks in the oil rig's drill riser—the portion of pipe connecting the surface drilling platform to the seafloor. In a side-by-side comparison, the researchers found that their model's reconstruction closely resembled an image of the actual fractured pipe taken by a remotely operated vehicle shortly after the accident occurred. The group presented their results at the International Offshore and Polar Engineering Conference in June.

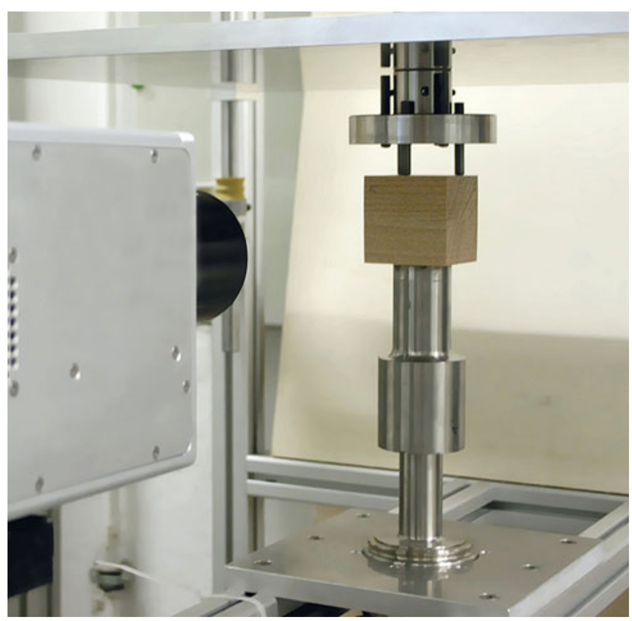
Tomasz Wierzbicki, professor of applied mechanics at MIT, says such a simulation could help oil and gas companies identify stronger or more flexible pipe materials that could help minimize the impact of a future large-scale accident. "We are looking at what would happen during a severe accident, and we're trying to determine what should be the material that would not fail under those conditions," Wierzbicki says. "For that, you need technology to predict the limits of a material's behavior."

For more information: Massachusetts Institute of Technology, Department of Mechanical Engineering, Room 3-173, 77 Massachusetts Ave., Cambridge, MA 02139; tel: 617/253-2201; fax: 617/258-6156; e-mail: mehq@mit.edu; web: http://meche.mit.edu/.

Ultrasound Vibration and Thermal Imaging Method Identifies Weakness in Solid Wood

Research scientists from the Fraunhofer Institute for Wood Research, Wilhelm-Klauditz-Institut, WKI in Braunschweig are able to pinpoint defects in wood that cannot be seen with the naked eye. Using high-power ultrasound thermography they can detect longitudinal and transverse cracks, gluing errors, delaminations, and black knots. To do this they vibrate the wooden item using a sonotrode, or ultrasound agitator, at a frequency of 20 kHz (i.e., 20,000 times per second). Where there are defects, the different parts of the material rub against each other and produce heat. This heat at the extremities of the defect is picked up by a thermal imaging camera connected to a monitor; in the case of hairline cracks, frictional heat can be seen along the length of the crack as well. High-power ultrasound thermography even allows the researchers to probe beneath the surface to uncover dowels that have not been glued and defects hidden undercoatings—something that today's much less reliable testing methods, such as mechanical materials testing or electrical measuring, are simply not able to do.

"We can spot the imperfections in raw timber. That is crucial for rejecting defective wood before time and money



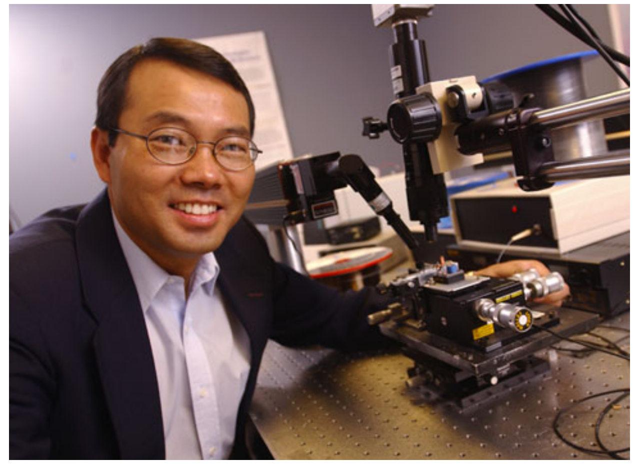
The ultrasound agitator causes the wood to vibrate, which generates frictional heat wherever there are cracks. A thermal imaging camera shows these defects. Photo courtesy of Fraunhofer WKI have been invested in processing it," says physicist Peter Meinlschmidt at the WKI. Whether the wood in question is oak, walnut, or beech is not important, and neither is the condition of the wood; defects in damp parts show up on the thermal imaging camera too. The depth to which the wood can be analyzed depends on its thermal conductivity, but up to 20 millimeters is possible. "Our process is especially suited for finding defects in high-quality solid wooden parts and window frame squares and to detect badly glued joints. It is a nondestructive testing method. Applying the ultrasound agitator does leave small pressure marks though—but these aren't an issue when you're dealing with raw timber," explains Meinlschmidt. The researchers have also used high-energy ultrasound thermography to detect cracks in ceramics and glass. A demonstrator of the ultrasound generator with thermal imaging camera has been built.

For more information: Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V., Postfach 20 07 33, 80007 Munich, Germany; tel: +49 89 1205-0; fax: +49 89 1205-7531; www.fraunhofer.de/en/.

Virginia Tech Photonics Center to Develop Sensors to Keep Power Systems Clean, Safe

Looking for novel sensing technologies that will aid in everything from clean energy technology to the monitoring of various gases, the U.S. Department of Energy (DOE) and the Electric Power Research Institute (EPRI) have selected Virginia Tech's Center for Photonics Technology to lead efforts in three unique projects. Jointly, the awards are valued at more than \$3.2 million. The photonics center has a history of achievements in the area of optical fiber sensors, and Anbo Wang, Virginia Tech's Clayton Ayre Professor of Electrical Engineering and director of the center, holds a number of patents on different sensing technologies.

- The first project, lasting 36 months, requires the center to work on a first-of-a-kind technology for remote fiber optic generation and the detection of acoustic waves for structural health monitoring. The envisioned technology would require no electric power supply at the monitoring site and at the detected acoustic signature, as well as the additional returned optical signal. It would allow the recording of information about multiple material conditions including temperature, strain, corrosion, and cracking.
- In the second project, Wang and his colleagues will develop a unique sensing platform to monitor the varying space and time properties of a gasifier's refractory wall. In a gasifier, a carbon-base material such as coal or petroleum can be converted at a high temperature into a gas, including hydrogen, carbon monoxide, or a synthetic gas. The temperatures may exceed 1000 °C. The term *refractory* refers to the materials that are used to line the walls of the gasifiers, protecting the shell of the gasification chamber from the very intense gasification process.
- Finally, the EPRI is funding a four-year study, asking the photonics center to investigate the validity of two approaches to monitoring and detecting hydrogen and acetylene. The use of fiber optic sensors for on-line detection of gas in transformers is useful because they have an "inherent immunity to electromagnetic interference, high sensitivity, light weight, and small size," Wang said.



Anbo Wang, director of the Center for Photonics Technology at Virginia Tech. Photo courtesy of Virginia Tech

For more information: Center for Photonics Technology at Virginia Tech, 460 Turner Street, Suite 303, Blacksburg, VA 24061-0287; web: http://photonics.ece.vt.edu/index.html.

Age-Hardening Process Avoids Discoloration of PH Stainless Steels

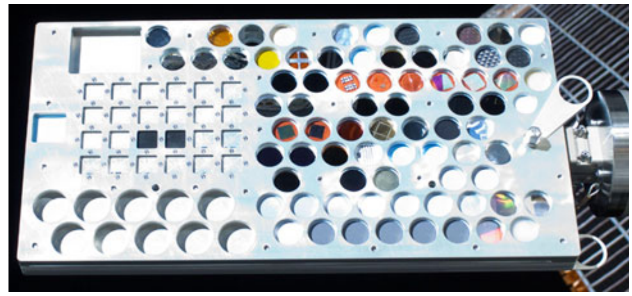
Precipitation-hardenable (PH) stainless steels 17-4 and 15-5 are required to be cooled to below 26.67 °C (80 °F) from the annealing temperature for complete martensitic transformation prior to age hardening. Similarly, PH stainless steels 13-8 Mo and 17-7 and 15-7 Mo Condition TH 1050 are required to be cooled from the annealing temperature to below 15.56 °C (60 °F) relatively quickly prior to aging. Once PH stainless steel has been exposed to an air environment after annealing, it is notoriously difficult to keep it "bright" or not to discolor (oxidize) to a gold/blue hue during the age-hardening step.

Solar Atmospheres has developed a two-step heat treat process featuring new gas-cooling technology to anneal and bright age harden a variety of PH stainless steels in a vacuum furnace without “breaking vacuum.” With this technology, PH stainless steels can be annealed, cooled down to below 15.56 °C (60 °F), and age hardened, all under vacuum conditions in a single heat treat, batch vacuum furnace process. The result is consistently clean, bright, nondiscolored parts that meet specification processing and material property requirements.

For more information: Solar Atmospheres, 1969 Clearview Road, Souderton, PA 18964-0476; tel: 800/347-3236; fax: 215/723-6460; e-mail: info@solaratm.com; web: www.solaratm.com.

Materials Tested on International Space Station

In the accompanying photo, taken during the spacewalk on July 12, 2011, the small circles are test beds for materials and computing elements attached to the outside of the International Space Station. These elements are being evaluated for the effects of atomic oxygen, ultraviolet, direct sunlight, radiation, and the extremes of heat and cold. Researchers hope the results will provide a better understanding of the durability of various materials and computing elements when they are exposed to the rigors of space environments and hope to incorporate what is learned into the design of future spacecraft.



Materials test beds on International Space Station Experiment-8. Photo courtesy of NASA

For more information: Public Communications Office, NASA Headquarters. Suite 5K39, Washington, DC 20546-0001; tel: 202/358-0001; fax: 202/358-4338; e-mail: public-inquiries@hq.nasa.gov; web: www.nasa.gov. ■