superconducting current density as a function of temperature (between 4.2 and 80 K) and magnetic field (≤ 7 T), the researchers found the dislocation density to be proportional to B*, that is, the magnetic field up to which the critical current j_c (B) remains constant, before starting to decay. Up to B* all vortices are pinned, each by one linear defect. Above B*, essentially no defect is available and the remaining vortices are located at interstitial sites. These unpinned vortices are then responsible for the resulting decay in j_c.

Accordingly, the researchers report that "no correlation is found between the density of linear defects and the value of the critical current density...which shows that the critical current at low fields is solely determined by the pinning of single vortices along extended defects."

Use of Optical Tweezers Uncovers Micromechanical Properties of Dipolar Chains in Magnetorheological Suspensions

In order to understand how magnetorheological (MR) fluids behave at the microscopic level, professor Alice P. Gast and graduate student Eric M. Furst of the Chemical Engineering Department at Stanford University applied optical trapping techniques as they studied an MR suspension consisting of superparamagnetic particles dispersed in a nonmagnetic fluid. As reported in the May 17 issue of *Physical Review Letters*, Gast and Furst used polyvinyl microspheres to manipulate the particles in MR fluids. Because the presence of iron oxide disrupts the action of the optical tweezers, the researchers attached "tethers" consisting of nonmagnetic microspheres. Using two optical tweezers, they were able to grip the tether spheres and use them to pull apart individual chains of magnetized spheres while measuring the amount of force that was required.

The researchers found that it takes about four times the force to pull the chains apart than the simple models had predicted. The researchers suggest that the models, which treat the particles as simple point dipoles, do not consider that each particle generates its own local field, which acts to stiffen particles nearby.

They also found that, as they were pulling chains apart, extra spheres frequently popped into the chain. Such additions lowered the tension in the chain momentarily, and caused the chains to fail more gradually than previously predicted.

As Gast and Furst varied the strength of the magnetic field, they found that at very high field strengths, the chains form and cross-link to give the material a solid form. At low field strengths, the chains disintegrate. At intermediate strengths, the material becomes elastic and the researchers found that the chains can undergo a reorganization into mechanically stronger configurations, similar to work hardening in plastics.

As the individual chains joined together to form columns, the scientists found an increase in tensile strain of a short dipolar column as the dipole strength decreased.

Artificial Capsules (Polymersomes) Mimic Biological Cells

Bioengineers from the Institute for Medicine and Engineering (IME) at the University of Pennsylvania have designed an artificial capsule called a polymersome that imitates many of the qualities of natural cells. Daniel Hammer, professor of chemical engineering, said "The polymersomes are the same size as natural cells, but their outer membrane is much tougher than the phospholipid membrane of biological cells." He also said that the capsules are undetectable by the human immune system so they can be used to deliver drug therapies.

As reported in the May 14 issue of *Science*, the researchers produced the capsules from the diblock copolymer EO_{40}-EE_{37}. They dried the carbon-based polymer and an organic solvent on a wire, added water to the system, and applied electricity to the wire. Over time, as the polymer film lifted off the wire's surface, capsules formed.

According to Dennis Discher, assistant professor of mechanical, chemical, and bioengineering, the largest artificial cell made prior to these are 1 μm in diameter, whereas the polymersomes range from 10 to 35 μm. Most human cells are 10 μm.

Currently, a chemical tag made from polyethylene oxide is used to make lipid capsules and other biological delivery vehicles invisible to the immune system. The polymersomes have this polyethylene oxide tag built in.

The research team found that the polymersomes are an order of magnitude tougher than other capsules that more closely resemble natural cells. This resiliency is important for any capsule that would experience repeated stress, for example when buffeted about in the human circulatory system, they said. Discher said, "The polymersomes can withstand fluid stresses in physiological solutions for up to a month without falling apart."

The researchers furthermore said that because the polymersomes are made synthetically, scientists have wider control over the properties they can engineer. Polymersomes also mimic the way biological cells change shape in response to environmental factors, such as density or temperature. □

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WASHINGTON NEWS

Congress May Trim FY 2000 Funds for Spallation Neutron Source

The Department of Energy's (DOE) Oak Ridge National Laboratory (ORNL) has recently been chosen as the site for the construction of the next generation Spallation Neutron Source (SNS). The SNS is a collaborative project involving ORNL and four other DOE national laboratories (Argonne, Brookhaven, Lawrence Berkeley, and Los Alamos) designed to meet the growing needs in the U.S. research community for more powerful neutron sources (see Washington News in *MRS Bulletin*, May 1998, page 9).

Increasing pressures on Congress to cut federal discretionary spending during Fiscal Year 2000 could result in a reduction in funding for SNS, now nearly one year into its design phase at Oak Ridge. The final amount of the cutback remains uncertain until the actual budget is approved in October. An interim vote in late May by the House Science Committee determined that $96-million could be slashed from the $214-million originally requested for FY 2000, according to sources on both Capitol Hill and inside DOE.

This cutback, according to DOE officials, would cause delays in the development of major SNS components, inevitably result-

https://doi.org/10.1557/S0883769400052805

ing in the loss of key staff, as well as overall cost escalations. The current schedule for SNS calls for the design phase to be completed during FY 2001; hard construction from FYs 2002–2004, including installation of the technical systems; testing in FY 2005; and operations starting in FY 2006.

At one point in the deliberations, House Science Committee Chair James Sensenbrenner (R-Wis.) pushed to prohibit SNS construction entirely. However, with further negotiations, committee members voted to provide $118-million-including $100-million for construction and $18-million for operations and research and development.

Although Sensenbrenner was persuaded by colleagues—in particular, committee members Jerry Costello (D-Ill.) and Bart Gordon (D-Tenn.)—to approve partial funding for the project, congressional staffers said the chair remains dissatisfied with the information DOE has provided about SNS so far. Sensenbrenner has promised no further opposition to the project once his requirements have been met, but as of early summer his dissatisfaction remains, and he has been pressing DOE for more precise estimates of the project's costs and construction schedule.

Sensenbrenner said, "I think it's just flat out irresponsible for us to authorize construction of this project without better projections from DOE."

His view has been echoed by Science Committee vice chair Vernon Ehlers (R-Mich.), "I support SNS. But it should not be started until we clear up the lingering questions."

On the Senate side, as of early summer, an energy and water development appropriations subcommittee has voted a total of $187-million for the SNS in FY 2000, including $169-million construction and $18-million operations and R&D—or $27-million less than requested. That figure is considered the minimum workable funding level for FY 2000, according to DOE officials. "We can get most of the work done at that level," one official said, adding, "Of course, anytime you receive an appropriation that's less than you requested, it's bound to have an effect."

A DOE internal review committee had been scheduled to meet at Oak Ridge last month in order to compile new detailed cost and schedule base lines for SNS. DOE officials said that the SNS review is a routine procedure: Semi-annual progress reports are compiled on every major project at the national research laboratories. The previous internal management evaluation, conducted by DOE last January and February, resulted in a major staff reorganization and the appointment of David Moncton as SNS Project Director at Oak Ridge. Moncton supervised the construction of the Advanced Photon Source at the Argonne National Laboratory.

Overall, SNS faces the same funding problem as do all federal scientific research programs: Congress is looking at spending about $1 billion less on such efforts next year than in FY 1999.

PHIL BERARDELLI

> **For commentary on the Spallation Neutron Source (SNS), see:**
> "Spallation Neutron Source to Provide Facilities to Conduct World-Class Science," by Thomas Weber (NSF) in the Public Affairs Forum in *MRS Bulletin*, February 1999, page 11 or on website www.mrs.org/pa/editorials/.

NRC Recommends Continuation of U.S./Russian Joint Program to Contain Russian Nuclear Material

In response to heightened concern that plutonium and uranium could be stolen or diverted from facilities in Russia to create nuclear weapons, a committee of the National Research Council (NRC) recommends that the U.S. government continue supporting a cooperative program dedicated to improving the security of Russian nuclear materials for at least a decade. The committee published a report saying that Russian nuclear materials that could be used in weapons are more extensively dispersed and inadequacies in security systems are more widespread than previously estimated.

Since a 1997 Research Council review of the joint program between the United States and Russia, the U.S. government has identified more facilities in Russia where nuclear materials are stored, and has determined that more extensive security upgrades are needed. Moreover, some Russian institutions do not have the funds to pay salaries or to ensure that security systems are installed and operated as intended. The recent decline in the Russian economy has resulted in financial hardship for many Russian government officials, nuclear specialists, and workers who have access to such material, the committee said, providing added incentive for materials to be stolen and sold illegally.

Building upon the 1997 Research Council report, the committee identified several priorities that the program should address, including the following: (1) consolidating material into a fewer number of buildings; (2) increasing Russia's capacity to manage and support nuclear security; (3) protecting large quantities of spent fuel once used for maritime purposes, research, and in breeder reactors; (4) negotiating to remove political, legal, and administrative barriers that impede progress in the program; and (5) improving the management of U.S. personnel and financial resources.

Copies of *Protecting Nuclear Weapons Material in Russia* can be obtained from the National Academy Press, 2101 Constitution Ave., NW, Washington, DC 20055; 202-334-3313 or 1-800-624-6242. □

PUBLIC AFFAIRS FORUM

CMMP Committee Supports Strategies to Advance Interdisciplinary Research

The following article is taken from a report published in the December 1998 issue of BPA News, *a publication of the National Research Council's Board on Physics and Astronomy.*

I chaired the Committee on Condensed-Matter and Materials Physics (CCMMP), which was commissioned by the National Research Council's Board on Physics and Astronomy to prepare a volume on this field as part of the decadal physics survey, *Physics in a New Era*. Our Committee* recently completed its report, and this article is based on its executive summary.

Condensed matter and materials physics (CMMP) plays a central role in many of the scientific and technological advances that have changed our lives so dramatically in the last 50 years. CMMP gave birth to the transistor, the integrated circuit, the laser, and low-loss optical fibers so important to the modern computer and communication

*The other members of the Committee included James B. Roberto (Oak Ridge National Laboratory), Gabriel Aeppli (NEC Research Institute), Arthur Bienenstock (who left the Committee to take up the position of Associate Director for Science at the Office of Science and