



Inkjet printing is used to make polymer organic LED display prototypes at a Cambridge Display Technology Ltd pilot plant and is being explored by other manufacturers for small-molecule OLEDs.

get away with less uniformity in the organic layers and less capable current-driving circuitry, but patterning colors is very difficult to do in larger sizes with current masking equipment," says Columbia University electrical engineer Ioannis Kymissis.

Light-emitting polymers can be scaled up more easily, through spin-coating or ink-jet printing. In 2004 Seiko Epson Corp developed a 102-cm-diagonal polymer OLED TV prototype that used CDT's technology. Now, the printer manufacturer is also collaborating with Universal Display Corp, holder of the original phosphorescent small-molecule patents, on a process that puts small molecules into solution for printing. Universal Display's vice president of technology commercialization, Janice Mahon, says that direct printing is an exciting area, but she adds that vacuum evaporation processes can become cost-effective and commercially viable for large-area OLEDs. DuPont Displays Inc. has already developed a small-molecule printing process, says William Feehery, director of the company's OLED business. "We are banking on [printing] as the future of OLED technology."

Other factors play into the cost and performance of OLED displays. Manufacturers must reduce the cost of the thin-film transistor backplane needed to drive current through large-screen OLEDs, says Optoelectronics Industry Development Association president Michael Lebbey. The lifetime of OLED emission has also been an issue, but researchers say the blue-light lifetime has

now improved to around 20 000 hours, or six years of average TV use. Many OLED manufacturers, including Universal Display and CDT, have also improved the efficiency of OLED lighting, but with large commercial TVs now in sight, the immediate focus is on displays. "There's been a lot of excitement in this field" since Sony's TV was released, says Forrest, "but we still have more work to do."

Jermy N. A. Matthews

DOE officials detail security concerns at labs

The Department of Energy's top counterintelligence official dismissed assertions by the former counterintelligence chief at Lawrence Livermore National Laboratory (LLNL) that a 2007 restructuring of DOE's security programs has left the nuclear weapons complex more vulnerable to spying. But he and other DOE officials testifying at a recent House hearing warned of a growing risk to DOE's labs and other weapons assets from cyberattacks, which are increasing in number and sophistication. Directors of the weapons laboratories conceded that further protections should be made to their computer networks.

Stanley Borgia, the highest ranking of 21 Federal Bureau of Investigation agents who are detailed to counterintelligence posts in the DOE complex, told the House Committee on Energy and Commerce that former LLNL

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official Terry Turchie was “wrong” to warn that the congressionally mandated merger of the intelligence and counterintelligence offices at DOE could hinder detection of espionage at LLNL and other weapons facilities. Turchie, who retired in 2007 as the counterintelligence chief at LLNL, wrote to committee chairman John Dingell (D-MI) in September, warning that “the vulnerability of DOE personnel and facilities to hostile intelligence activities has increased exponentially” because of the DOE reorganization. Turchie was not among the witnesses testifying at a 25 September hearing of the committee’s oversight and investigations subcommittee, and the committee issued a statement afterward dismissing his concerns.

The merger reversed a 1999 congressional directive for the establishment of a separate counterintelligence function within DOE. That elevation came in the wake of allegations that China had stolen nuclear secrets from the labs.

Cyberattacks increasing

DOE officials also reported that malicious attempts to penetrate the computer networks at the labs and other DOE facilities are on the rise. Dingell charged that the labs “are virtually naked to concerted cyberattacks, especially by assault from persistent, well-funded, and dedicated assailants.” Attacks numbered more than 400 million in each of three recent months, Borgia said. DOE inspector general Gregory Friedman said the frequency of attacks has jumped 45% over the past year. Hackers range from relatively harmless curiosity seekers to those originating from “nation-state and belief-based espionage,” said Linda Wilbanks, the chief information officer for DOE’s National Nuclear Security Administration. Asked whether some breaches in cybersecurity may have gone undetected, Borgia answered simply “yes” and left further elaboration to a closed hearing that followed the public session.

Lab directors reassured lawmakers that classified information isn’t at risk in cyberattacks. That top-secret material is kept on secured internal networks that are “air gapped,” or physically separated from, internet connections. A second, “yellow” network restricted to the labs and their collaborators does contain sensitive but unclassified data such as personnel records, business proprietary information, and information relating to naval reactors and other nuclear facilities. Though protected by firewalls, the yellow network is accessible from the internet to a number of foreign nationals

who have security clearance and to others. That network presents “a valuable target for foreign governments, terrorists, and spies,” warned Gene Aloise, director of natural resources and environment at the Government Accountability Office (GAO), who noted that 13 000 users at Los Alamos National Laboratory have access.

Friedman, who has authored numerous reviews urging DOE to upgrade its cybersecurity, said the ongoing concern “is one of the most perplexing issues I deal with.” The department has failed to follow through on numerous cybersecurity measures it has initiated, he said.

Wilbanks and Bradley Peterson, DOE’s chief of nuclear security, said cybersecurity upgrades are under way. More than half of the recommendations contained in a recent GAO report will be implemented by December, and the remainder will be in place by the end of 2009, they said in their joint testimony.

Mock terror attack

The hearing also covered concerns over the state of LLNL’s physical security; committee members pointed out that the lab’s protective force had failed to repel a mock terrorist assault last April. The DOE Office of Independent Oversight found the guards’ performance lapses during the exercise “shocking and so serious” that they couldn’t be discussed in an open hearing, Dingell said. Glenn Podonsky, DOE’s chief health, safety, and security officer, said “key equipment malfunctions” and “some difficulty in implementing response actions” were to blame. Among other problems, the lab’s security force was unable to deploy a key element of its defenses—an enormous truck-mounted Gatling-type machine gun capable of firing 4000 rounds per minute and with a kill range of more than a mile.

LLNL director George Miller said that health and safety considerations limited the guard force’s options in response to the simulated terrorist attack. Officers, for example, were not allowed to use ladders to climb onto the roof of the “superblock,” the highly secured warehouse in the lab complex where fissile materials are kept. They were also prohibited from using smoke and engaging in “realistic exercises” inside the facility. Guards performed far better during a mock terrorist attack held in August, and a DOE review of that drill said the lab now has “a robust protection strategy,” according to Miller.

David Kramer

Bubble fusion scientist disciplined

After making headlines with claims of achieving nuclear fusion in a tabletop experiment, Rusi Taleyarkhan joined Purdue University’s nuclear engineering department in 2004. His tenure there has been rocky. After a university investigation cited Taleyarkhan for two instances of research misconduct, the university imposed sanctions in August. Taleyarkhan will remain a member of the university’s faculty and can serve on graduate committees, but he will no longer have a named professorship and will not be allowed to serve as a major professor for graduate students for at least three years.

The saga began in 2002, when Taleyarkhan was at Oak Ridge National Laboratory. He and his colleagues had subjected a flask of deuterated acetone to very intense, high-frequency sound waves, causing the formation of tiny bubbles that expanded and contracted in phase with the sound. Theorists had predicted that the compression-induced shock wave in a sufficiently spherical bubble could create high enough temperatures and pressures for deuterons to fuse. Taleyarkhan’s team presented evidence that such fusion had indeed occurred. But their report, published in *Science*, met with considerable skepticism. (See PHYSICS TODAY, April 2002, page 16.)

Independent research groups have so far failed to confirm the results of Taleyarkhan’s group, and controversy has dogged him. Some have criticized the experiments. Others have leveled charges of misconduct. Purdue convened two successive investigations in 2006 and 2007 to explore those allegations. Neither investigation charged Taleyarkhan with wrongdoing.

Still, questions lingered. Even the subcommittee on investigations and oversight of the House Committee on Science and Technology weighed in, criticizing what it regarded as a limited investigation by Purdue. (See PHYSICS TODAY, June 2007, page 36.) The university established a third investigation in November 2007. In its 18 July report to Purdue, the investigation committee charged Taleyarkhan with misconduct relating to the authorship of a scientific paper and to the characterization of a certain experiment as an “independent” confirmation of bubble fusion.

One of the sonoluminescence experts whose group has not been able to