An analysis of public policy issues and how they affect MRS members and the materials community...

Materials Science and Nonproliferation: Scientists Influence National Policy

When I accepted the position of the 1997 Materials Research Society/Optical Society of America Congressional Science and Engineering Fellow in the office of Edward J. Markey (D-MA), one of my first tasks was to coordinate the creation and development of a Bipartisan Task Force on Nonproliferation. Our inaugural meeting featured former Soviet leader Mikhail Gorbachev speaking about his Cold War memories to a room that was packed to overflowing. The next event was a "Codeword Clearance" CIA (Central Intelligence Agency) briefing on China's nonproliferation record, and a later highlight was the Washington, DC preview of the movie *Peacemaker*, with free tickets for congressional members and their key staff, and a reception with the "real-life" Nicole Kidman (Jessica Stern, a Fellow at the National Security Council at the time of the events covered in the movie) and George Clooney (a composite of various players).

As I delved deeper into the issues and legislation surrounding nonproliferation, I began to realize how important a role materials science and engineering plays. Materials scientists or engineers influence more than federal funding for research and development; they have an impact on U.S. science and technology policies, which often play a defining role in national policy.

Consider some of the current nonproliferation issues facing the country:

▪ **Disposition of excess weapons plutonium.** As the START treaties are implemented, both the United States and the Former Soviet Union (FSU) will be dismantling their nuclear weapons. Both countries have experienced challenges and difficulties in keeping the excess weapons materials secure in the post-Cold War world, and the faster they are converted into a proliferation-resistant form, the better. In December 1996, the Clinton Administration announced a dual-track approach to disposing of weapons plutonium. Some would be vitrified and buried, and some would be converted to a mixed-oxide (MOX) fuel and burned in civilian nuclear reactors prior to deep underground burial. Controversy surrounds the issue, since the FSU is unlikely to accept vitrification alone as a viable option, but many U.S. government officials and scientific experts believe that creating a civilian economic value for plutonium by burning MOX fuel would pose a proliferation risk itself, and this second method appears to be far more expensive. Materials science will be vital to either track pursued: Purifying the plutonium and converting it into a ceramic form will be necessary for both vitrification and the MOX option, and materials scientists will need to design glasses that will safely encase the materials for tens of thousands of years if the vitrification track is chosen.

▪ **Detection of biological and chemical agents.** At press time, Saddam Hussein has again renegotiated procedures with United Nations inspectors after denying them access to Iraqi facilities, and the United Nations and U.S. Pentagon among other experts believe it is because the inspectors were close to discovering Iraqi biological and/or chemical weapons capability. Materials science technologies such as thin-film sensors, high-porosity glass foams, aerogels, and the tiny "lab on a chip" are being developed to detect chemical and biological agents.

▪ **Stockpile stewardship.** The United States has recently decided to cease the development of new nuclear weapons, and sometime in 1998, the Senate is expected to ratify the Comprehensive Test Ban Treaty (CTBT). While these policy measures should be welcomed as tangible signs of the end of the Cold War, scientists must now find ways to guarantee the safety and security of the nuclear arms the United States continues to maintain. High performance computing will be used to model and predict the behavior of aging nuclear weapons, but this must be augmented by real-life stockpile sampling and enhanced surveillance. For instance, if 1960s-era electronics in a nuclear weapon need to be replaced, scientists must be able to guarantee that the 1990s electronics retains the same or better security and reliability while remaining compatible with the rest of the device—without detonating it. Materials scientists believe that one way to enhance U.S. knowledge of the stockpile state-of-health and obtain information about potential problems with a weapon is to use tiny silicon microsystems that include sensors to detect changes in temperature, pressure, or composition.

▪ **Treaty verification and cooperative monitoring.** One of the key features of any arms control treaty is whether the United States can verify that other countries are living up to their side of the bargain. That is especially true for the CTBT, where there exist many scenarios for low-yield nuclear tests conducted by other countries that could escape detection. Although the recent explosive event that occurred near a site where the FSU was known to conduct nuclear detonations was determined to be non-nuclear in nature, that determination took some weeks to make definitively. Many CTBT verification technologies involve sensitive optics, detectors, and seismology to determine whether an explosion was nuclear in origin. A variety of materials technologies are being developed to assure that sensitive materials have not been moved or tampered with during the course of international inspections. For instance, shrink-wrap made out of several layers of films can be patterned to acquire a unique signature when heat is applied. If the materials are moved, the signature is disturbed as well. Similarly, reflective hematite particles embedded in polymer films can be used to tag sensitive materials.

Scientists' voices can be very powerful in this policy debate. The key witnesses that will testify at hearings on the CTBT will likely all be scientists and engineers by training, answering questions about the technological capability to verify and monitor the treaty as well as to guarantee the safety and reliability of the U.S. stockpile. As materials scientists, we have an opportunity as well as an obligation to contribute to this debate.

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For news on this topic and related issues, see Washington News in the following issues of *MRS Bulletin*:
December 1997, p. 10; August 1997, p. 14; and February 1997, p. 12.

To express your opinion and comments on the science policy issues associated with ratification of the Comprehenisve Test Ban Treaty, e-mail to public_affairs@mail.mrs.org.

https://doi.org/10.1557/S0883769400031390 Published online by Cambridge University Press