# Nuclear detector: New materials hold promise for better detection of nuclear weapons

September 12 2011

Northwestern University scientists have developed new materials that can detect hard radiation, a very difficult thing to do. The method could lead to a handheld device for detecting nuclear weapons and materials, such as a "nuclear bomb in a suitcase" scenario.

"The terrorist attacks of 9/11 heightened interest in this area of security, but the problem remains a real challenge," said Mercouri G. Kanatzidis, who led the research. "We have designed promising semiconductor materials that, once optimized, could be a fast, effective and inexpensive method for detecting dangerous materials such as plutonium and uranium."

Kanatzidis is a Charles E. and Emma H. Morrison Professor of Chemistry in the Weinberg College of Arts and Sciences. He also holds a joint appointment at Argonne National Laboratory.

The Northwestern materials perform as well as materials that have emerged from five decades of research and development, Kanatzidis said.

To design an effective detector, Kanatzidis and his team turned to the heavy element part of the periodic table. The researchers developed a design concept to make new semiconductor materials of heavy elements in which most of the compound's electrons are bound up and not mobile.

When gamma rays enter the compound, they excite the electrons, making them mobile and thus detectable. And, because every element has a particular spectrum, the signal identifies the detected material.

The method, called dimensional reduction, will be published in the Sept. 22 issue of the journal *Advanced Materials.*

In most materials, gamma rays emitted by nuclear materials would just pass right through, making them undetectable. But dense and heavy materials, such as mercury, thallium, selenium and cesium, absorb the gamma rays very well.

The problem the researchers faced was that the heavy elements have a lot of mobile electrons. This means when the gamma rays hit the material and excite electrons the change is not detectable.

"It's like having a bucket of water and adding one drop -- the change is negligible," Kanatzidis explained. "We needed a heavy element material without a lot of electrons. This doesn't exist naturally so we had to design a new material."

Kanatzidis and his colleagues designed their semiconductor materials to be crystalline in structure, which immobilized their electrons.

The materials they developed and successfully demonstrated as effective gamma ray detectors are cesium-mercury-sulfide and cesium-mercury-selenide. Both semiconductors operate at room temperature, and the process is scaleable.

"Our materials are very promising and competitive," Kanatzidis said. "With further development, they should outperform existing hard radiation detector materials. They also might be useful in biomedicine, such as diagnostic imaging."

**More information:** The paper, titled "Dimensional Reduction: A Design Tool for New Radiation Detection Materials," is available at onlinelibrary.wiley.com/doi/10 … /adma.201102450/full

Provided by Northwestern University