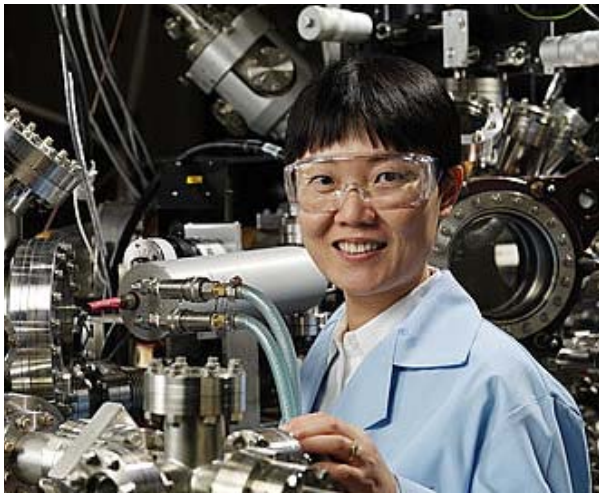
The Science of Collision

What happens when a fast moving ion meets a solid?

When an ion collides with a solid, two types of reactions can happen: the ion knocks atoms off their positions in the solid or the ion transfers energy to electrons. The first reaction is becoming fairly well understood. However, the second reaction, which occurs at the level of single electrons, is not, leaving scientists to either ignore the consequences of the reaction or to make a simplistic and frustrating assumption that this energy becomes heat. At the Department of Energy's EMSL, Yanwen Zhang from EMSL and William Weber from Pacific Northwest National Laboratory have worked over the years to overcome this simple assumption by determining what really happens to that energy transferred to electrons.



Integrating EMSL resources, researchers Yanwen Zhang (shown) and William Weber gained insights into ions and their interactions with surfaces.

Part of this research has involved obtaining highly accurate measurements of the energy lost to electrons in the collision. Because of the size and speed of the ions, able to travel nearly 2 million miles in a minute, the scientists created an instrument to measure the speed or time of flight of a single ion before and after it passed through a thin film. By measuring the speed of different ions before and after passing through the film, they determined how much energy each ion deposited in the film and were thereby able to provide the data needed to fundamentally understand ion interactions with materials that range for stellar dust to radiation detectors.

Beyond these measurements, Zhang and Weber are using this experimental approach, along with scientists at Stanford University and a private company, to rapidly learn about the responses of many types of materials to radiation. The approach also allows rapid screening of new materials to develop new types of efficient gamma radiation detectors. Testing thousands of different materials for detectors is expensive and time consuming, as each material must first be turned into a large crystal. However, with the new method, the scientists can test the efficacy of materials with films just a few tens of micrometers thick, saving the construction of expensive test crystals for the most promising materials.

The answers from this and other work could lead to new materials and devices for nuclear reactors, space exploration, and radiation detectors. This is part of EMSL's efforts to characterize surfaces with unprecedented spatial resolution.

For more information, contact EMSL Communications Manager Mary Ann Showalter (509-371-6017).

References: Zhang Y, and WJ Weber. 2009. "Response of Materials to Single Ion Events." *Nuclear Instruments and Methods in Physics Research: Section B* 267(8-9):1705-1712.

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