Pacific Northwest NATIONAL LABORATORY

When Atoms Collide

Method that can validate nuclear collision models benefits IAEA

RESULTS

A novel technique for materials research is unexpectedly also contributing to the nuclear safety efforts of the International Atomic Energy Agency. Pacific Northwest National Laboratory scientist Dr. Weilin Jiang and his team developed a novel analytical method for measuring the concentration of oxygen atoms at different depths in solid samples. Because their data, published in 2003, can also be used to validate theoretical models that describe how likely nuclear reactions can occur, it caught the attention of the IAEA.

This research is helping the International Atomic Energy Agency work for the safe, secure, and peaceful uses of nuclear science and technology.

WHY IT MATTERS

In addition to materials applications such as detecting metal corrosion and characterizing insulation layers used in electronic devices, the data can also be used to validate theoretical models of complex nuclear interactions. The research is also relevant to the structural materials used to build nuclear reactors, nuclear waste confinement facilities, and space vehicles. Nuclear processes can cause such materials to deteriorate over time, so assessing and predicting their performance is critical for safe and successful nuclear operations.

In 2011, the team's published data were included in IAEA's EXFOR database. EXFOR is an extensive, publicly available collection of experimental nuclear reaction data used by a broad cross section of the research community, from materials scientists to nuclear physicists.

Jiang is honored to contribute to EXFOR noting that, "The IAEA database is quite selective."

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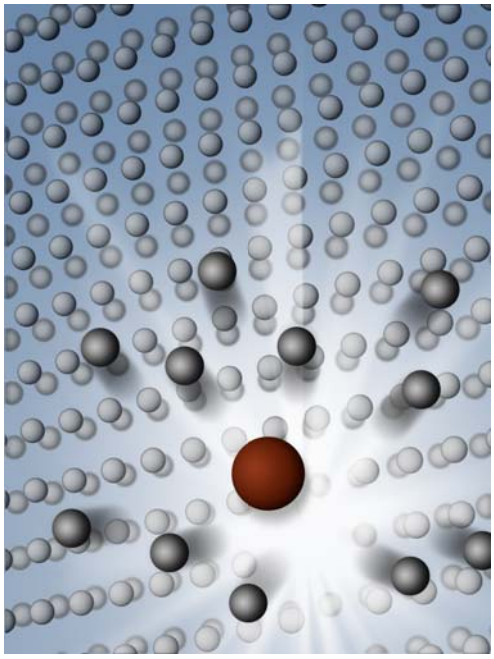

At Pacific Northwest National Laboratory, researchers created nuclear-reaction analytical methods to study oxygen behavior in solid samples. The methods can be used to investigate ceramic oxides with great potential in future nuclear energy systems, nuclear waste forms, security devices, and space vehicles.

U.S. DEPARTMENT OF ENERGY

The data incorporated into the IAEA database can be used to validate theoretical models of complex nuclear interactions and is also relevant to the structural materials used to build nuclear reactors, nuclear waste confinement facilities, and space vehicles.

METHODS

Using EMSL accelerator capabilities and a silicon dioxide (SiO_2) thin film as a standard, the researchers bombarded the SiO_2 thin film with helium or deuterium ions traveling at different speeds and carrying different amounts of energy. Using a number of techniques, they detected the reaction products emitting from the thin film. The measured yield from the oxygen nuclear reaction is proportional to the probability at which the nuclear reaction occurs. An example was demonstrated for measuring the concentration of oxygen atoms at different depths in a solid sample. Oxygen diffusion in solid materials or at interfaces can be studied using the method.

WHAT'S NEXT?

This research is contributing to PNNL's ongoing materials science research. Oxide ceramic materials are analyzed at PNNL using the developed method. Efforts are focusing on nanocrystalline ceramic materials and single crystals that are resistant to nuclear irradiation.

ACKNOWLEDGMENTS

Funding: U.S. Department of Energy Office of Science, Office of Basic Energy Sciences, Materials Sciences and Engineering Division.

User Facility: EMSL

Research Team: Weilin Jiang, Suntharampillai Thevuthasan, and Vaithiyalingam Shutthanandan.

REFERENCE

W Jiang, V Shutthanandan, S Thevuthasan, DE McCready, and WJ Weber. 2003. "Oxygen Analysis Using Energetic Ion Beams." Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms 207(4):453-461.

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January 2012 | PNNL-SA-85137

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