Digging into the details of uranium dioxide for nuclear fuel

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Exploring the magnetic and thermal properties of uranium dioxide (UO_2), researchers at Los Alamos and Idaho national laboratories and at the Aix-Marseille University in France are improving understanding of an essential nuclear power plant fuel.

"This research is important because we need to fully understand the magnetoelastic properties of UO_2 in order to fill in the gaps in our knowledge about this important fuel material," said Marcelo Jaime, a Los Alamos National Laboratory researcher who is lead author of a paper in Nature Communications published the week of July 24, 2017. "The interplay we're seeing between the lattice structure and its unique magnetic properties might have important implications for its thermal properties, especially thermal conductivity."

The project was led by Krzysztof Gofryk, a staff scientist at Idaho National Laboratory (INL). "There are still some new surprises as we work to unravel all of the reasons behind the exotic thermal properties of uranium dioxide," Gofryk said. "We discovered tiny distortions in the crystals' cubic shape that lead to piezomagnetism, and they switch along with the polarity of high magnetic fields – up to 92.5 Tesla." Tesla (T) is a unit of measure for the strength of magnetic fields. One Tesla is more than 20,000 times stronger than earth's magnetic field.

The experiments into the material's magnetic sensitivity under pressure were performed at the National High Magnetic Field Laboratory's Pulsed Field Facility at Los Alamos National Laboratory. Supported by the U.S. Department of Energy (DOE), the National Science Foundation (NSF), and the State of Florida, the PFF is the only facility in the world capable of generating magnetic fields to 100T in a non-destructive fashion, a world record held since 2012.

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World Record Magnetic Field 100T

Better understanding of the unusual thermal conductivity in UO_2 is of great interest for those developing advanced new fuels and models of the material properties. Further research in these areas could lead to safer and more economic reactor design, which is an important part of DOE missions.

The paper, "*Piezomagnetism and Magnetoelastic Memory in Uranium Dioxide*," was published in *Nature Communications.*

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In addition to Gofryk and Jaime, other co-authors of the Nature Communications paper include: A. Saul, M. Salamon, V.S. Zapf, N. Harrison, T. Durakiewicz, J.C. Lashley, D.A. Andersson, C.R. Stanek, and J.L. Smith.