Study could change nuclear fuel

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The adverse effects of radiation on nuclear fuel could soon be better controlled thanks to research involving UT's College of Engineering.

Maik Lang, an assistant nuclear engineering professor, is part of a team of researchers that has studied how specific properties of materials involved in nuclear energy production, and their performance, can change their response to radiation.

In particular, Lang and the other researchers looked at actinide materials—which include well-known elements like uranium and thorium—and their response to highly ionizing radiation.

"The systematic study of valence changes in irradiated actinide oxides showed that the redox behavior of the actinide elements governs the radiation tolerance of the nuclear material," Lang said.

In simplest terms, redox reactions are chemical reactions in which the oxidation state of atoms changes, involving the transfer of electrons between chemical species. In actinide oxides, redox changes lead to a gain or loss of oxygen atoms.

Using uranium and thorium as their base actinides and altering variables such as the grain size, Lang and the group were able to observe changes in the redox rate, helping discover the complex relationship between each variable and a corresponding radiation behavior.

"The exposure to radiation degrades the performance and safety of

nuclear fuels. By limiting the redox activity of actinide materials through control of composition or microstructure, we can mitigate radiation-induced swelling and microstrain of the nuclear material," Lang said.

With this new understanding, Lang and the group have opened up the possibility of designing more radiation-tolerant nuclear fuels.

"By increasing the performance and 'shelf life' of fuels in the intense radiation field of a nuclear reactor, the overall cost of energy production could be decreased while at the same time increasing power, a win-win for the industry and consumers," he said.

News of the breakthrough has already gotten the attention of those in the field, with the highly regarded journal *Nature Communications* publishing the work.

More information: "Redox response of actinide materials to highly ionizing radiation." *Nature Communications* 6, Article number: 6133
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