Nuclear Fuels and Materials Science

Every type of technology benefits from advances inspired by new knowledge and understanding. Although nuclear energy has operated safely in the U.S. for more than 50 years, nuclear engineers continue to devise new ideas for making nuclear energy even safer and more secure. The future of reliable nuclear energy requires scientific research to verify that new types of advanced nuclear fuels and materials are robust enough to withstand the conditions inside a nuclear reactor during normal and abnormal conditions.

What's the difference between nuclear fuels and materials?

Nuclear fuels contain fissionable elements — typically uranium — surrounded by material such

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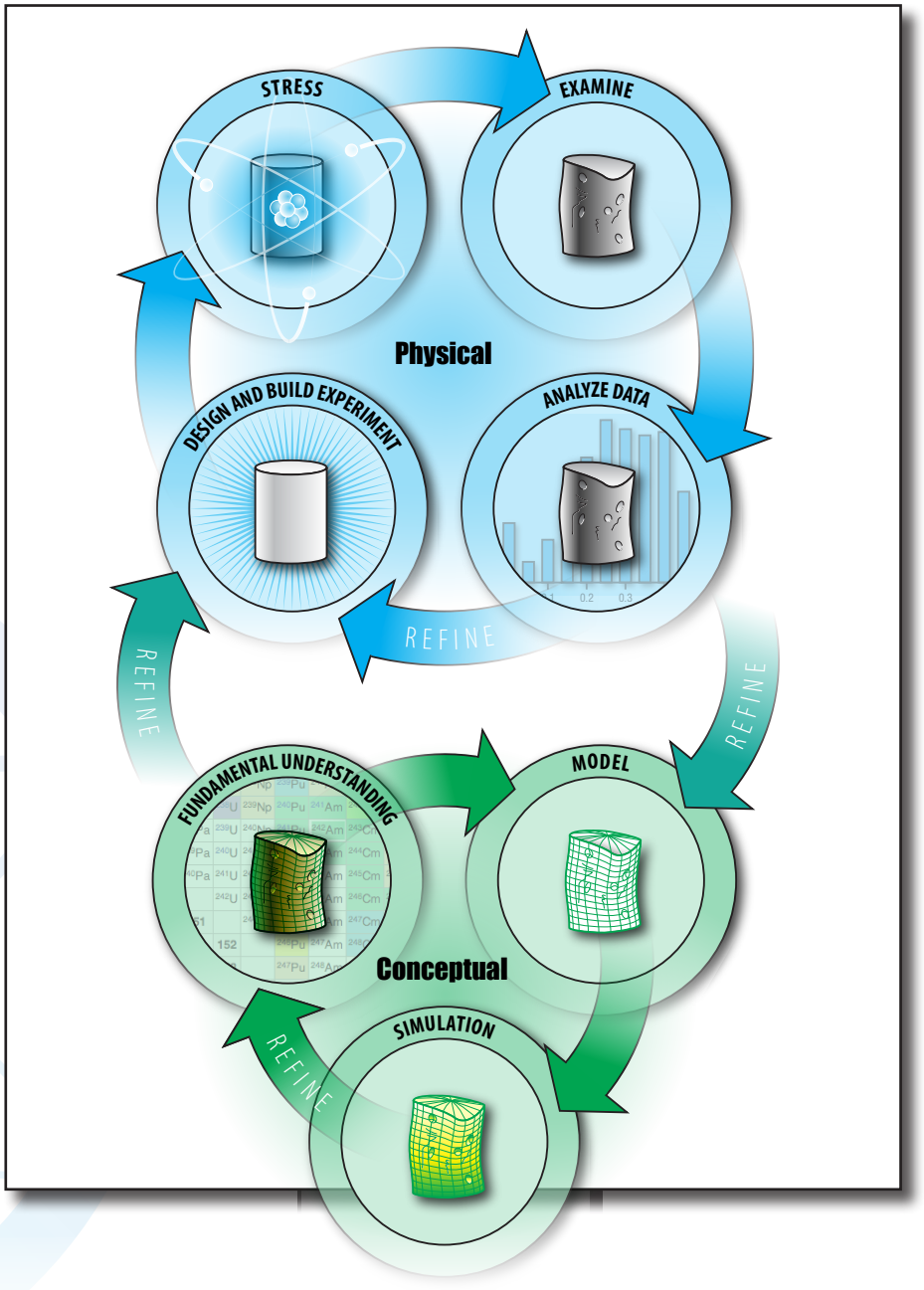
The nuclear materials research process builds and refines knowledge based on physical data and conceptual simulations.



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as aluminum or zirconium alloys (cladding). Reactor materials include the steels and other alloys that make up the rest of the reactor, such as the vessel and cooling system components.

How does the research make reactors safe?

The nuclear energy industry and its independent regulator (the Nuclear Regulatory Commission) require extensive testing and validation before new types of fuel or component alloys can be used in an operating reactor. Fuels and materials that perform well under punishing test conditions verify confidence about how they'll perform in an operating nuclear energy facility.

How are fuels and materials tested?

Just as in other disciplines, nuclear scientists and engineers build an experiment, perform a test, then analyze the results to confirm or revise their assumptions. The process is just more complicated for those working with radioactive materials, which require extra safety precautions.

Scientists and engineers build on existing knowledge to devise a new concept or material. Modeling and simulation can inform the process by capitalizing on the full extent of existing information, but models only enable simulations based on known information. When the limit of knowledge is reached, an experiment can provide new insight.

For nuclear science, researchers create a small sample of the material they want to test and subject it to radiation, temperature and/or pressure conditions mimicking those inside a nuclear power reactor. Scientists then examine the material to see how it held up.

If the test conditions cause extensive damage, scientists can study the cause and devise solutions. Strong performance under a host of punishing test conditions verifies confidence about how materials will perform in an operating nuclear energy facility.

For more information

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INL facilities and capabilities make the lab a "one-stop-shop" supporting every step of the nuclear research cycle.