

NUCLEAR REACTOR FUEL

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This lecture will address key material aspects of fuel for nuclear reactors. Nuclear fuel is at the heart of the nuclear fission process as it provides the source of the energy generated (fissile material) as well as the source of the radiological risks originating from nuclear reactor operation (fission products). Its thermal, mechanical and chemical properties and behaviour are of key importance to assess the safety of nuclear reactors.

A variety of fuel materials have been considered in the course of time, and a short historical overview of the development will be given. Presently, almost all nuclear power reactors use uranium oxide as fuel form, some use mixtures of the dioxides of uranium and plutonium, and we will focus strongly on these materials. The fabrication processes of these fuels will be discussed.

The heat produced in the pellet leads to a significant temperature gradient during irradiation as a result of the properties of the material. It is important that the temperature of the fuel remains below the melting during all conditions and therefore one needs to have a detailed knowledge of the thermal diffusivity and thermal capacity of the fuel. These properties strongly depend on the composition, microstructure but as on the crystal chemistry of the materials, as will be explained in detail.

During irradiation not only temperature, but also the effects of a changing chemical composition as a result of the fission process, as well as radiation due to decay will play a role. The behaviour of fission products in the fuel can be understood on the basis of examinations of fuel rods after irradiation. This will be presented using examples from such examinations.

1. R.J.M. Konings, T. Wiss and C. Guéneau, *Nuclear Fuels*. In: *The Chemistry of Actinides and Transactinide Elements*, 4th Edition (L.R. Morss, J. Fuger and N.M. Edelstein, Eds.), Volume 6, Chapter 34, p. 3665-3812, Springer Netherlands, 2010.