Preparation and characterization of Pd-NPs doped UO_2 samples: nanotechnology approaches to evaluate the behavior of spent nuclear fuel in deep geological repositories.

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Abstract

To assess the safety of the hypothetical future deep geological repository (DGR) of Spent Nuclear Fuel (SNF), several studies have been centered in the SNF behavior in contact with groundwater. The SNF contains transuranium elements as well as fission products, such as I, Sr, Cs, Mo, etc. Some of the fission products (i.e., Pd, Pt, Rh…) are found in metallic form as epsilon particles. Besides, due to radiolysis, oxidizing species are expected to be formed in the near field of the SNF and they could oxidize the SNF matrix to more soluble U(VI) solid phases. Nevertheless, ε-particles could prevent this oxidation and, therefore, protect the SNF[1].

The most conservative projections consider that it may take 1000 years until water comes into contact with the fuel. At this situation there might be a series of steps or reactions between the SNF and water (water radiolysis, fuel oxidation, fuel dissolution and precipitation of secondary phases). Each stage will be influenced by a series of parameters such as pH, temperature, composition of water and pressure. Specifically, water radiolysis will result in both oxidant (H_2O_2, O_2) and reducing (H_2) species. However, the main presence of hydrogen is expected to come from the anoxic corrosion of the steel canisters containing the SNF. [2–5]

In this communication we present the application of Pd-NPs to the preparation of doped UO_2 samples, in order to simulate the presence of ε-particles into SNF. For Pd-NPs, the advantages of nanometric scale are reflected as enhanced catalytic activity and gas storage[6]. Advanced Electron Microscopy and X-Ray Photoelectron Spectroscopy (XPS) characterization are presented in order to stablish the influence of the presence of Pd-NPs on the oxidation processes of UO_2 under representative DGR conditions.

References

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Figures

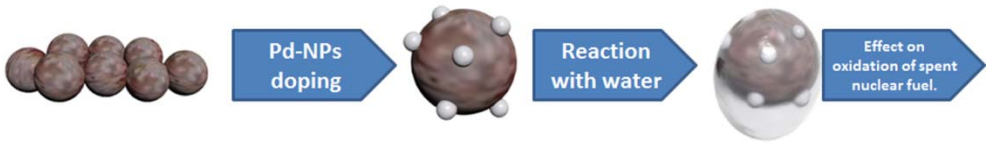

Figure 1: Stages for the evaluation of the effect of Pd-NPs over the oxidation of uranium oxide in DGR