II. Fabrication of CeO_2 by sol-gel process

Using the equipment in our laboratory, CeO_2 spheres were fabricated by internal gelation. Once the mixed broth was dropped into the hot silicone oil, it started to gel immediately, and the color of the broth changed from transparent yellow to semi-translucent yellowish brown. After having aged for 30 min, the gelled spheres were collected in a stainless steel basket. The collected unwashed spheres were then aged in 12.5% (m/m) NH_4OH for 0.5 h, and then the gelled spheres were washed firstly by CCl_4 to remove the silicone oil and then with 0.5 mol/L NH_4OH to remove excess HMTA, urea, and ammonium nitrate. The air dried spheres shrink and have a diameter of 1 mm. The dried spheres were calcined up to 500 ℃ for 4 h and then sintered up to 900 ℃ for 2 h to get phase pure cerium oxide[2]. The sintered spheres have a diameter of only 600 μm and their color turn into yellowish white, which is the same color of cerium oxide. Some of the spheres cracked when they were sintered.

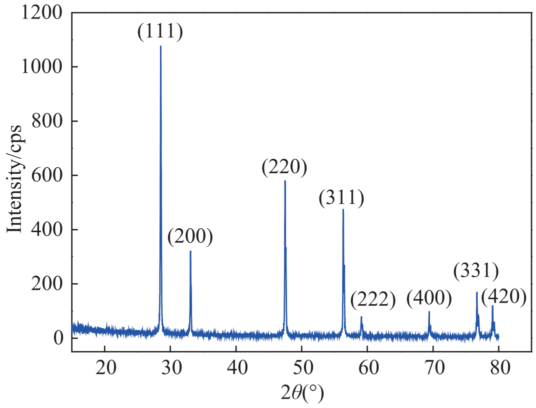

Fig. 2 (color online) XRD pattern of sintered spheres.

III. Lattice structure of the sintered spheres

Fig. 2 shows the XRD pattern of the sintered spheres. The XRD pattern spectra are assigned to cubic fluoride structure with a Lattice parameter of 5.40 Å, and the Miller indices correspond to each identified diffraction peak. The XRD pattern of the sintered spheres is exactly same as the standard CeO_2, which means the sintered spheres have a quite pure phase structure.

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2 - 32 Release and Gathering of Semi-volatile Fission Products (Mo, Te) in the UO_2 Simulated Fuel

Tan Cunmin, Chen Desheng, Cao Shiwei and Qin Zhi

The volatilization technology, which is used for pulverizing uranium oxide ceramic pellets, decladding, and removal of most of volatile and semi-volatile fission elements from spend fuel, has been developing as main treatment process for ADS nuclear fuel cycle. In the oxidation/reduction steps (400 ℃ to 600 ℃), most of the volatile nuclides such as Kr, Xe, C-14, H-3, can be removed. However, the higher temperature is needed to release semi-volatile fission products.

Westphal *et al.*[1] at INL reported release rates of semi-volatile fission products (Cs, Te, Rh, Tc-99, Ru, Tc, Mo) during oxidation of spent fuel from 500 ℃ to 1 250 ℃. Song *et al.*[2] at KAERI showed that release rates of Kr-85, C-14 during OREOX process, and the release fraction of semi-volatile Cs was ∼16% during a reduction at 1 000 ℃ of the oxidized powder, but over 90% during the voloxidation at 1 250 ℃. From the experimental data by INL and KAERI, and published data[3,4], *etc*, release rates of Cs is 98% during PRESENT (Particle size control, REmoval of fission product, SElective gaseous Nuclide Trapping) process[5]. Those of Kr, Xe, H-3, C-14, I-129 are 100%. And, those of Tc, Ru, Rh, Te, Mo and Rb are 92%, 98%, 83%, 53%, 62% and 96%, respectively.

In our present work, the release and gathering of Mo and Te, as two typical elements of semi-volatile fission products, were researched for simulating the volatilization technology. On the basis of the previous studies in the pulverizing process，a small amount of oxides of Mo and Te (MoO_3 and TeO_2) was added in the UO_2 simulated fuel powder and the efficiency of release was researched in different temperatures. As shown in Fig. 1, MoO_3 and TeO_2 both begin to evaporate when the temperature is higher than 800 ℃. The rates of release, reached the maximum at 1 100 ℃ ∼1 200 ℃, are 70% and 88%, respectively.

After that，the gathering experiments of MoO_3 and TeO_2 were carried out. The results (Fig. 2) confirmed that, MoO_3 is mainly gathered under 750 ℃ and TeO_2 under 850 ℃. Both the distributed regularity of oxides is strongly influenced by gas, which deposited with the spread of air in the quartz tube.

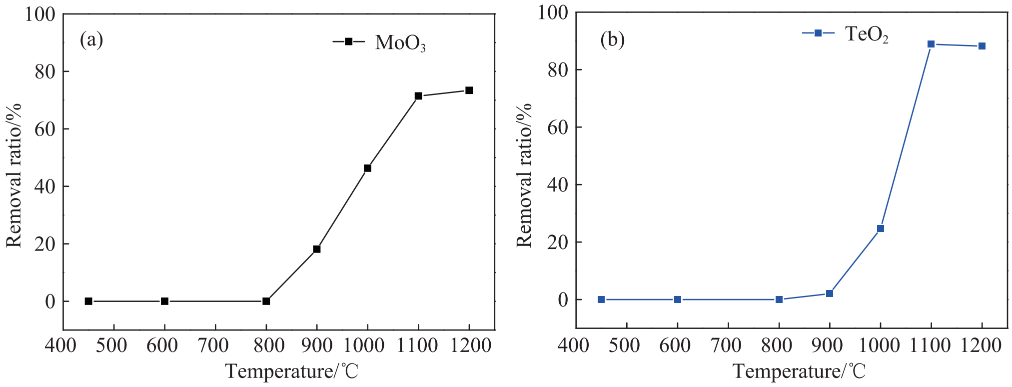

Fig. 1 (color online) The release of MoO_3 and TeO_2.

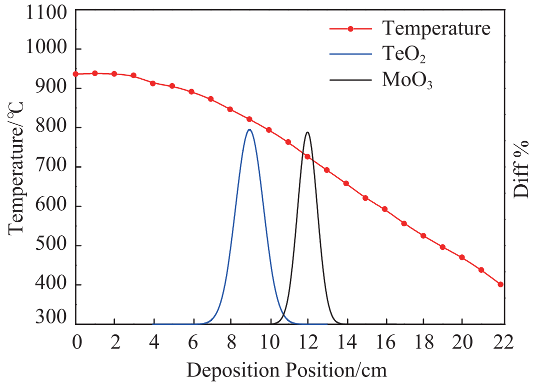

Fig. 2 (color online) The gathering of MoO_3 and TeO_2.

References

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2 - 33 Synthesis of Amidoximated Silica and Its Application for Uranium Adsorption from Saline Lake Brine

Yin Xiaojie, Bai Jing and Qin Zhi

Sorption is an effective method for uranium recovery from saline lake brines for the benefits of simplicity, rapidity and easy recycling. To make uranium extraction feasible, solid adsorbents which are effective under saline lake brine conditions should be developed. In present work, MCM-41 type silica adsorbents with different content of amidoximated groups were prepared via co-condensation method according to the following steps: 1 g of CTAB was dissolved in 135 mL of deionized water and then 102 mL of ammonia was added to the solution. After stirring for 0.5 h, CTES and 5 mL of TEOS were mixed and added to the homogeneous solution. The mixture was stirred for 2 h at room temperature. The powder was recovered by filtration, purified with plenty of 10/90 HCl/C_2H_5OH and dried at 60 ℃. The specific molar ratio of CTES/TEOS was obtained by controlling the quantity of CTES. The obtained silica grafted with nitrile(-CN) named CMCM-X ($X = 0$, 0.2, 0.4 or 0.6) were treated with 3 g $NH_2OH{\cdot}HCl$ in 100 mL 50/50 H_2O/CH_3OH solution for 72 h at 80 ℃. Sodium carbonate was used to adjust the solution pH to neutral. The final products, denoted as AMCM-X, were washed with deionized water and dried at 60 ℃.

Fig. 1 showed the FTIR spectra of CMCM-0, CMCM-0.4, AMCM-0.4 and AMCM-0.6. The large broad band at 3 427 cm^{-1} and the band at 1 630 cm^{-1} were attributed to the stretching vibration of Si–OH group and the adsorbed water. The bands at 1 085, 800 and 470 cm^{-1} were related to the stretching vibration, typical symmetric and bending vibrations Si–O-Si in the silica, respectively. The stretching band of the free silanol groups at 960 cm^{-1}