2 - 40 Influence of Different Oxidation Temperature on Phase Separation Characteristics of $(U_{1-x}Nd_x)_3O_8$ Solid Solutions

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Rare-earth (RE) elements in spent nuclear fuel are strong neutron absorbers, which affect the fission efficiency of fissile materials. If some of these fission products (*e.g.*, RE) can be removed by a thermo-mechanical process, it will greatly improve the burn-up and economics of the recycled fuel in the DUPIC (Direct Use of spent PWR fuel in CANDU Reactors) concept[1,2]. In this work, the phase separation characteristics of the Nd (3%) element from $(U_{1-x}Nd_x)_3O_8$ by high temperature oxidation was investigated in terms of the heat treatment temperature range between 1 000 °C and 1 700 °C. The phase separation ratio (wt%) of Nd and U was evaluated using the XRD. The morphology of the samples were obtained from SEM.

The XRD patterns of the powders produced by the heat treatment of $(U_{1-x}Nd_x)_3O_8$ powder at a temperature range between 1 000 °C and 1 700 °C are shown in Fig. 1.

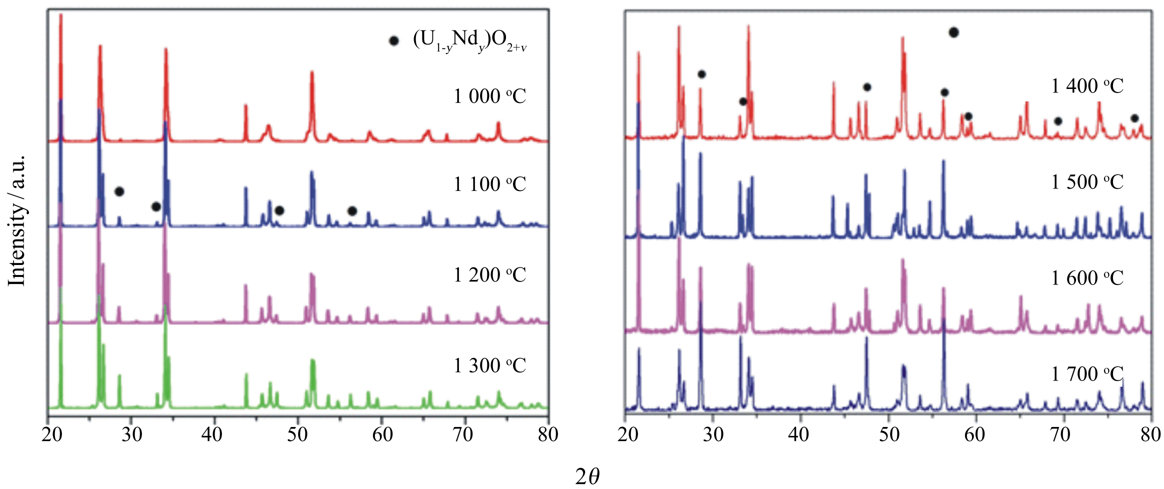

Fig. 1 (color online) XRD patterns of the powders produced by oxidation of $(U_{1-x}Nd_x)_3O_8$ powders with the different heating temperature.

For a quantitative analysis, the fraction of the $(U_{1-y}Nd_y)O_{2+v}$ phase was calculated by means of the following equation:

$$f = \frac{I(U_{1-y}Nd_y)O_{2+v}}{I(U_{1-y}Nd_y)O_{2+v} + I(U_{1-z}Nd_z)_3O_{8-w}} \ ,$$

Where $I(U_{1-y}Nd_y)O_{2+v}$ (RE-rich) and $I(U_{1-z}Nd_z)_3O_{8-w}$ (RE-poor) are the integrated intensity of $2\theta = 28^\circ$ and 21.4°. The fraction of the heat treatment temperature as shown in Fig. 2. The amount of the $(U_{1-y}Nd_y)O_{2+v}$ phase in the oxidation products increased with an increase in the heat treatment temperature.

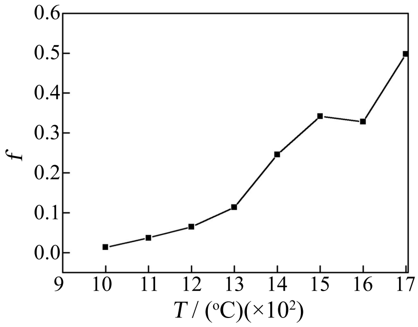

Fig. 2 Fraction of the Nd-rich $(U_{1-y}Nd_y)O_{2+v}$ phase produced by oxidation of $((U_{1-x}Nd_x)_3O_8$ powders with the heating temperature.

Fig. 3 shows the SEM micrographs of the powders produced the heat treatment of $(U_{1-x}Nd_x)_3O_8$ powder at a temperature range between 1 000 °C and 1 700 °C. Above 1 100 °C, the $(U_{1-y}Nd_y)O_{2+v}$ particles were observed in the form of small particles as shown in Fig. 3(b). It present increased numbers with increasing temperature, which is according with the results of XRD.

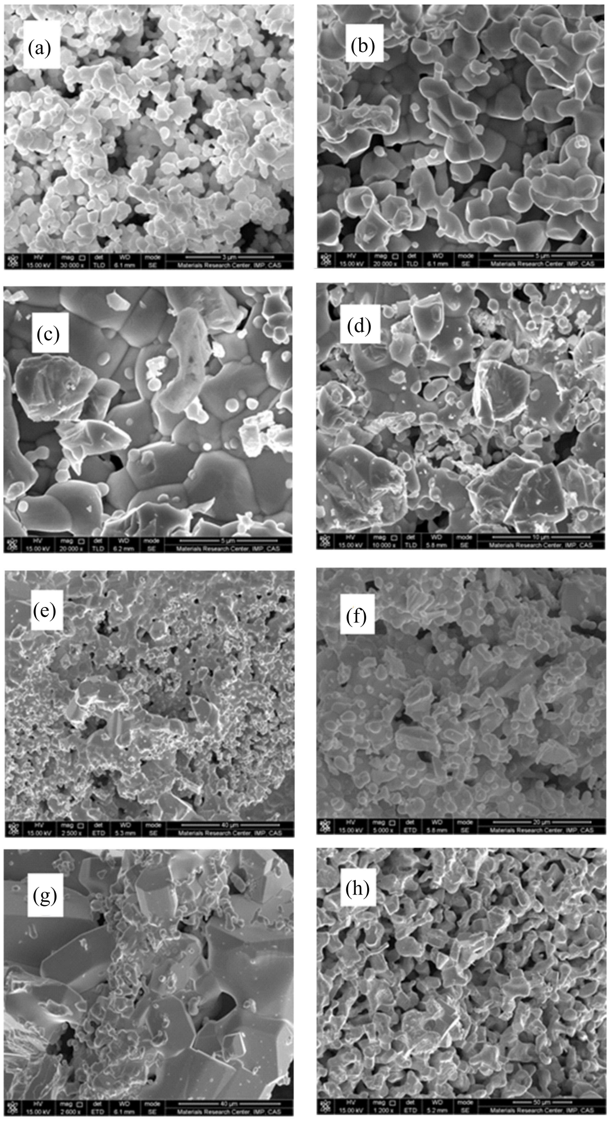

Fig. 3 SEM micrographs of the powder produced by oxidation of $(U_{1-x}Nd_x)_3O_8$ powders with the heating temperature (a) 1 000 °C, (b) 1 100 °C, (c) 1 200 °C, (d) 1 300 °C, (e) 1 400 °C, (f) 1 500 °C, (g) 1 600 °C, (h) 1 700 °C.

References

[1] J. S. LEE, K. C. SONG, M. S. YANG, et al., "Research and development program of KAERI for DUPIC (Direct Use of Spent PWR Fuel in CANDU Reactors)," *Proc. Int. Conf. and Technology Exhibition on Future Nuclear System, GLOBAL'93*, Seattle, USA, Sept. 12-17, 2006, p.733, American Nuclear Society(1993).

[2] Jae Won Lee, Yeo Wan Yun, Chung Han Kim, et al., J. Radioanal. Nucl. Chen, 299(2014)399.