

## RECYCLING OF MINOR ACTINIDES IN METAL FUEL FBR

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### 1. Recycling of minor actinides produced in LWR fuel cycle by FBR

CRIEPI has proposed an attractive option to recycle transuranium elements, Pu, Np, Am and Cm, produced in LWR fuel cycle, in FBR fuel cycle, which gives us an actinides cycle by FBR instead of uranium-plutonium cycle.

Transuranium Elements are recovered from high level liquid waste coming from purex type of reprocessing by dry process, which is expected to produce less amount of secondary waste and the compactness of the facility. The transuranium elements recovered are mixed with ternary alloy of uranium, plutonium and zirconium in order to transmute them to shorter half lived nuclides by a metal fuel FBR under developed as a next generation FBR. The dry process with pyrometallurgical separation causes to introduce the equivalent amount of rare earths as impurity in transuranium elements recovered, because of low separation factor which can be estimated from the thermodynamic data obtained electrochemically. The characterization study has been earned out on the fuel system of U-Pu-Zr-MA-RE, where MA means Np, Am and Cm, and RE indicates rare earths.

### 2. Selection of the alloy fuel with minor actinides for irradiation study

Based on the study[1] on the miscibility of binary alloys of actinides and of uranium-plutonium-zirconium with minor actinides and rare earths, the alloys of U-Pu-Zr with minor actinides of 2 and of 5 wt% together with rare earths of 2 and of 5 wt%, respectively, were selected for irradiation study in the fast reactor (see fig. 1).

### 3. Property of alloy fuel with minor actinides

Prior to the irradiation, the characteristics of the selected alloys has been evaluated. In the heat treatment study on alloy fuel with minor actinides and rare earths, rare earth phases including americium, which dispersed uniformly in the matrix as small size inclusion, grew at the grain boundaries by coalescence above 700 C (see fig.2). The evaporation of americium from the rare earth phases was observed above 850 C. The density of the alloy with minor actinides of 5% and rare earths of 5% decreased by around 9% compared with the ternary alloy. In addition to these results, the thermal conductivity measurement and the study of fuel/cladding interaction indicate that the alloys of U-Pu-Zr with minor actinides and rare earths will be able to tolerate the irradiation study in the fast reactor.

[1] T. Inoue, M. Kurata, L. Koch, J. C. Spirlet, C.T.Walker and C.Sari, Trans. Am. Nucl. Soc., 64,552 (1991).

Actinide Fuel ;

U 19Pu 10Zr 0.6Am 1.2Np 0.2Cm 2RE

U 19Pu 10Zr 1.6Am 3.0Np 0.4Cm 5RE

Reference Fuel ;

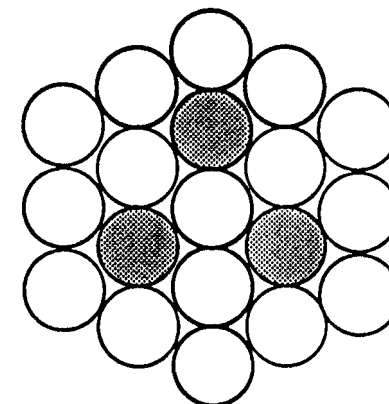
U 19Pu 10Zr

Operating conditions

$T_{\text{metal}} \leq 750 \text{ } ^\circ\text{C}$   $T_{\text{c}} < 1150 \text{ } ^\circ\text{C}$  (fuel melting)

$T_{\text{clad}} < 520 \text{ } ^\circ\text{C} \ll 725 \text{ } ^\circ\text{C}$  (eutectic

U-Pu-clad)



● : 3 metal pins  
○ : 16 oxide pins

Irradiation capsule

Fig. 1 Irradiation figure at PHENIX

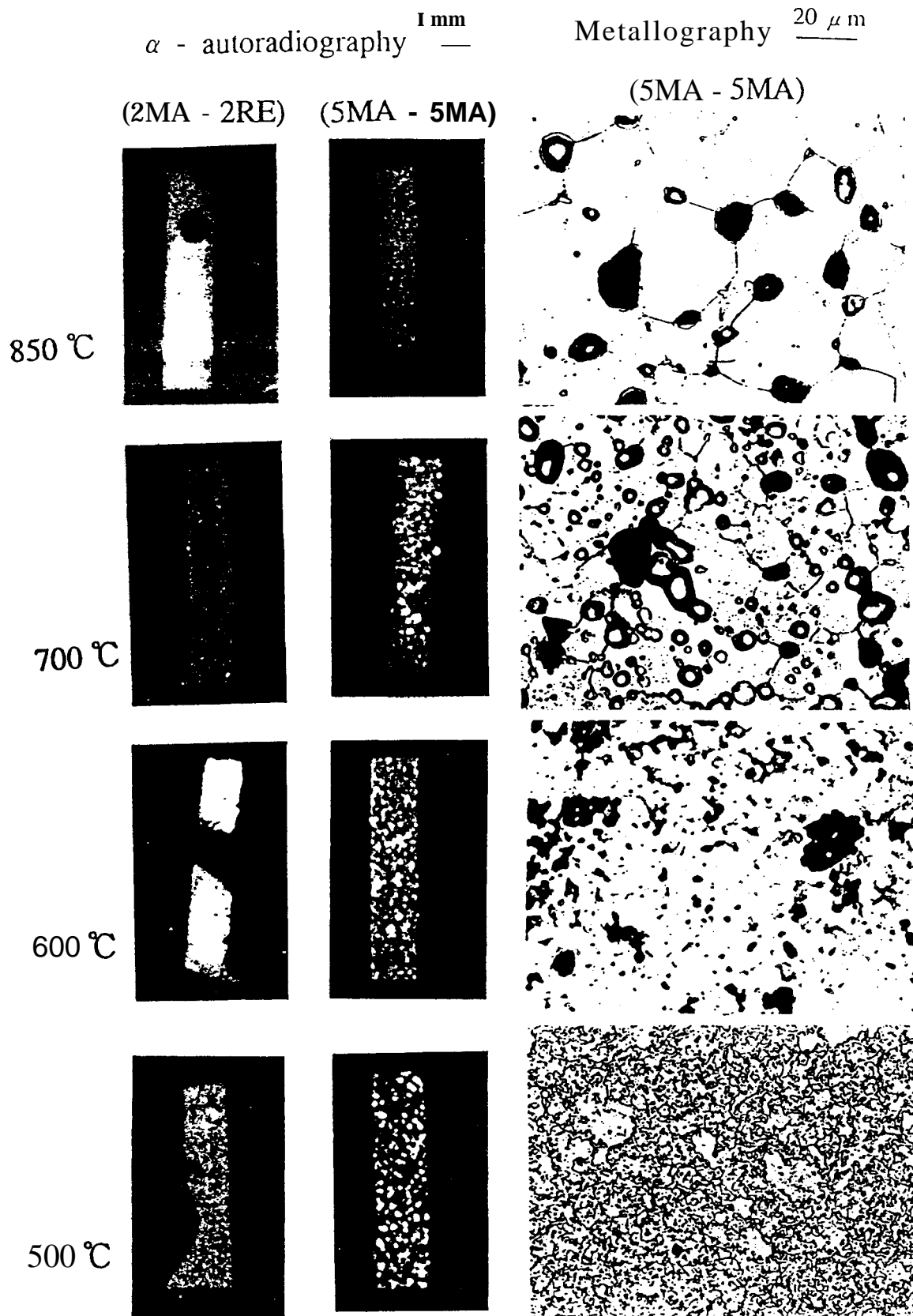


Fig. 2  $\alpha$  - autoradiographs and metallographs of alloys with 5% MA-5%RE and 2%MA-2%RE. The small white parts in the  $\alpha$  - autoradiography reveal the concentrated region of Am. The dark region in the metallograph corresponds to the Am-rare earth phase.