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The Solubilities of Selected Elements
in Liquid Plutonium
X. Thulium

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**The Solubilities of Selected Elements
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by

**D. F. Bowersox
J. A. Leary**

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ABSTRACT

The reversibility of the Tm-Pu system has been established at low Tm concentrations, and the solubility values for Tm in liquid Pu have been determined from 700^o to 1000^o C. The solubility, which was measured in both CaF₂ and Ta crucibles, increased from 1.67 % Tm (by weight) at 700^o C. to 6.15 % Tm at 1000^o C. The equation

$$\log N_{\text{Tm}} = 0.736 - 2.28 \times 10^3 T^{-1} ,$$

where N_{Tm} is the solubility expressed as the mole fraction and T is the temperature in degrees Kelvin, fits the data in the temperature range studied.

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INTRODUCTION

The solubilities of selected elements in liquid Pu are being studied in this Laboratory.⁽¹⁻⁴⁾ In these studies precautions have been taken to eliminate impurities, particularly oxygen, that might cause interactions and erroneous solubility values. The results of the study of the solubility of Tm in liquid Pu are summarized in this report. The study was limited to the temperature range 700° to 1000°C. Little has been published about the Pu-Tm system, and no evidence of compound formations has been reported in the range investigated.

EXPERIMENTAL

Analyses of the electrefined Pu⁽⁵⁾ and high purity Tm used in this study are given in Table 1. Both the equipment and the procedures have been described in an earlier report.⁽¹⁾ The estimated precision of the Tm analyses was ± 5 relative percent.

RESULTS

The reversibility of the Pu-Tm system was established at low Tm concentrations by several experiments. Constant solute concentrations were reached within 7 hr. at 950°C. upon approach from undersaturation, and less than 7 hr. was required to reach constant values upon approach from oversaturation. The solubility values were, in fact, constant and independent of the

Table 1
Analyses of Pu and Tm

<u>Element</u>	<u>p. p. m. in Pu^a</u>	<u>p. p. m. in Tm^b</u>	<u>Element</u>	<u>p. p. m. in Pu</u>	<u>p. p. m. in Tm</u>
Li	< 0.2	< 0.2	Co	< 10	< 0.1
Ce	< 0.1	< 0.1	Zn	< 10	< 10
Na	< 10	< 10	Am	824	---
Mg	< 10	< 5	O	25	---
Ca	< 10	< 5	Mo	< 1	< 0.5
Al	< 5	< 2	W	64 ± 2	---
La	< 10	< 5	Th	< 15	< 0.2
Si	6	< 10	Ta	< 35	< 0.5
Pb	< 1	< 0.2	Zr	< 10	< 0.5
Cu	< 1	< 1	H	10 ± 5	---
Ni	< 5	< 5	C	20 ± 10	---
Cr	< 5	---	F	< 2	---
B	< 0.5	< 0.5	U	< 30	---
Mn	< 1	10	Fe	< 20	---
Sn	1	< 0.2	Pu	99.98	---
Bi	< 1	< 0.5			

^aParts per million parts Pu, by wt.

^bParts per million parts Tm, by wt.

direction of approach after 7 hr. at temperature.

Solubility measurements were made in a random order from 700^o to 1000^oC. The solubility increased from 1.67% Tm, by weight, at 700^oC. to 6.15% Tm at 1000^oC. The data are summarized in Table 2.

The average values, as the atom percent of Tm, are plotted on a logarithmic scale against the inverse of the absolute temperature in Fig. 1. The equation

$$\log N_{\text{Tm}} = 0.736 - 2.28 \times 10^3 T^{-1} , \quad (1)$$

was calculated from all the solubility data by least squares methods of best fit. Values which were calculated at each temperature by Eq. 1 are listed in Table 2. The fit with the measured values is good; in fact, the chi-squared goodness-of-fit test indicates a probability greater than 99% that the measured and the calculated values are equivalent.

Table 2
The Solubility of Tm in Liquid Pu

Temperature, °C.	No. of Measurements	Average Solubility		Calc. Solubility ^a
		Wt. Percent	Atom Percent	Atom Percent
700	2	1.67 ± 0.04	2.35 ± 0.06	2.47
750	2	2.20 ± 0.03	3.08 ± 0.04	3.19
800	3	2.93 ± 0.13	4.09 ± 0.18	4.06
850	3	3.62 ± 0.10	5.04 ± 0.14	5.05
900	2	4.90 ± 0.07	6.79 ± 0.10	6.17
950	3	5.23 ± 0.05	7.25 ± 0.07	7.41
1000	2	6.15 ± 0.15	8.48 ± 0.21	8.77

^a Calculated by equation 1.

Fig. 1. N_{T_m} vs. $1/T$ (average solubility values)

REFERENCES

1. D. F. Bowersox and J. A. Leary, "The Solubilities of C, Ta, W, and Re in Liquid Pu," (in press).
2. D. F. Bowersox and J. A. Leary, "The Solubilities of Selected Elements in Liquid Plutonium VII. Niobium," LA 3436 (1965).
3. D. F. Bowersox and J. A. Leary, "The Solubilities of Selected Elements in Liquid Plutonium VIII. Molybdenum," LA-3523 (1966).
4. D. F. Bowersox and J. A. Leary, "The Solubilities of Selected Elements in Liquid Plutonium IX. Vanadium," LA-3594 (1966).
5. L. J. Mullins and J. A. Leary, Ind. Eng. Chem. Process Design Develop., 4, 394 (1965).