International Journal of Thermophysics, Vol. 24, No. 5, September 2003 (© 2003)

Effect of Heat Treatment on Thermal Conductivity of U-Mo/Al Alloy Dispersion Fuel[1]

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The molybdenum content of fuel core whose matrix is aluminium 1060, was varied to be 7, 8, and 10 wt% and the volume fraction of U-Mo fuel powders was varied to be 10, 30, and 40 vol%. In this work, thermal conductivities were calculated from measured thermal diffusivities, specific heat capacities, and densities, which were determined using the laser flash, DSC, and Archimedes methods, respectively. The thermophysical properties were measured over a temperature range from room temperature to 500°C. The U-Mo alloy was annealed at between 525 and 550°C for 1 to 36 hours. At high temperature, the U-Mo particles were reacted with aluminium matrix as forming layers of (U-Mo)Al_x. These reaction layers have been affected adversely by the thermal conductivity of fuel core. The thermal conductivities of annealed samples appeared to decrease with increasing volume fraction of the reaction layers.

KEY WORDS: density; specific heat capacity; thermal conductivity; thermal diffusivity; uranium-molybdenum alloy; U-Mo/Al dispersion fuel.

1. INTRODUCTION

The use of uranium-molybdenum alloys as a component in high-density LEU (low enriched uranium) dispersion fuels is very promising [1, 2]. The dispersion fuels in which uranium-molybdenum fuel particles are dispersed in the aluminium matrix had been developed to reduce the uranium

[1] Paper presented at the Sixteenth European Conference on Thermophysical Properties, September 1–4, 2002, London, United Kingdom.

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0195-928X/03/0900-1355/0 © 2003 Plenum Publishing Corporation

enrichment and test reactor fuel. The main goal of this program is the development of high-uranium density fuels that remain stable structures during fabrication and irradiation. Several kinds of uranium-based dispersion fuels such as U-Si, U-Zr, U-Mo, U-Nb, etc. were examined [3]. The U-Mo alloy would be a prime candidate for dispersion fuel for research reactors. The addition of molybdenum to uranium allows the metastable retention of the high temperature stable γ-phase which offers good properties in fuel elements. Several TTT curves for U-8 wt% Mo and U-10 wt% Mo predict minimal transformation of the gamma phase during fabrication [4]. The fabrication process and irradiation behavior of atomized U-Mo alloy dispersion fuel have been studied [5].

U-Mo alloys were subjected to heat treatments prior to irradiation in order to determine the effects of microstructure on fuel performance. Lower molybdenum alloys react with the matrix at a higher rate than high molybdenum alloys. Thermal conductivities of the preliminarily fabricated U-Mo/Al dispersion fuel core have been measured to estimate the center temperature of the irradiation fuels. Thermophysical properties such as thermal conductivity, specific heat capacity, and thermal diffusivity are required for reactor design or safety analysis.

Thermal conductivities at temperatures ranging from room temperature to 500°C were calculated by measuring thermal diffusivities, specific heat capacities, and densities of uranium-molybdenum/aluminium dispersion fuel core. The uranium-molybdenum content of dispersion fuel core was varied to be 7, 8, and 10 wt% and the volume fraction of U-Mo fuel powders was varied from 10 to 40 vol%.

In this work, the thermal diffusivity and specific heat capacity of U-Mo/Al dispersion fuel were measured over a temperature range from room temperature to 500°C by means of a laser flash apparatus and DSC (differential scanning calorimeter), respectively, to investigate the variation in the thermal conductivity. Then the thermal conductivity of U-Mo/Al dispersion fuels can be calculated from the measured specific heat capacity and thermal diffusivity.

2. EXPERIMENTAL PROCEDURE

2.1. Sample Preparation

The samples for thermal diffusivity and specific heat capacity measurements are described in Table I. The U-Mo fuel powders were fabricated by a centrifugal atomized method. The samples for thermophysical properties measurements were consolidated by hot extrusion. Three kinds of U-Mo/Al dispersion fuel core were prepared, that is, U-10 wt% Mo,

U-8 wt% Mo, and U-7 wt% Mo. The matrix material is Al-1060, similar to pure aluminium. The condition of heat treatment was determined by preliminary experiments [6] based on the reaction layer formed in this temperature range. After the heat treatment, samples were fabricated for the thermophysical properties measurements. Most of the heat treatments were carried out for 1 to 3 hours at 525°C. The microstructure examinations for the fuel core were carried out by scanning electron microscopy (SEM).

The densities of aluminium, molybdenum, and uranium are 2.698, 10.220, and 18.950 $g \cdot cm^{-3}$, respectively [7]. The density of dispersion fuel is about 3.8 to 8.7 $g \cdot cm^{-3}$ and depends upon the volume fraction of U-Mo powder.

Table I. Samples of Heat-Treated U-Mo/Al Dispersion Fuel

Name	Composition	U-Mo Volume fraction (vol%)	Heat treatment conditions	Density ($g \cdot cm^{-3}$)	Thickness of reaction layer (μm)	Thermal conductivity[a] ($W \cdot m^{-1} \cdot K^{-1}$)
U10M_1	U-10 wt.% Mo/Al	10	525°C, 2 h	3.93	*2.09*	176.3
U10M_2			525°C, 8 h	3.83		186.0
U10M_3			525°C, 11.5 h	3.90	5.36	174.6
U10M_4		30	525°C, 40 min	7.08	7.28	125.4
U10M_5			525°C, 1 h	6.79	1.51	103.4
U10M_6			525°C, 10.5 h	6.43	3.00	72.6
U10M_7		40	525°C, 1.2 h	8.18	6.26	64.3
U10M_8			525°C, 12 h	8.22	2.74	58.2
					5.86	
U8M_1	U-8 wt.% Mo/Al	10	525°C, 1.5 h	4.17	2.57	166.7
U8M_2			525°C, 7 h	4.03	4.71	136.5
U8M_3		30	525°C, 3 h	6.98	3.32	85.7
U8M_4		37.6	525°C, 16 h	7.90	1.20	82.4
U8M_5		40	525°C, 3 h	8.72	2.74	57.3
U7M_1	U-7 wt.% Mo/Al	30.7	No heat treated	7.23	–	116.1
U7M_2			525°C, 1 h	7.18	–	121.3
U7M_3			525°C, 4 h	6.73	–	89.4
U7M_4			525°C, 7.5 h	6.51	–	78.0
U7M_5			525°C, 30 h	5.99	–	55.2
U7M_6			500°C, 2.5 h	7.20	–	128.1
U7M_7			500°C, 4 h	7.07	–	120.7
U7M_8			550°C, 2 h	6.37	–	87.8
U7M_9			550°C, 7.5 h	6.64	–	86.1

[a] At room temperature.

After heat treatment, the U-Mo alloy was reacted with aluminium matrix. The dispersion fuel formed (U-Mo)Al_x reaction layers. These reaction layers affected the thermal conduction in fuel core.

2.2. Thermal Diffusivity Measurements

The thermal diffusivity (α) was measured by the laser flash method over a temperature range from room temperature to 500°C using a SinKu-RiKo (TC-7000VH/L) laser flash apparatus. The thermal diffusivity is determined by measuring the half time, which is the time that the temperature on the back surface of the sample increases to half of its maximum temperature rise. An InSb infrared detector senses the temperature rise of a sample. The sample is located at the center of a tungsten mesh heater in a vacuum atmosphere. In order to stabilize the absorption of incident energy, graphite is sprayed on the surface of the sample. The samples for the laser flash method are shaped into a disk of about 2 mm in thickness and 10 mm in diameter. The experimental data of thermal diffusivity for the pulse width effect were corrected by the method of Azumi and Takahashi [8]. The thermal diffusivity data were obtained from an average of five measurements, and the standard deviation in the measurement of thermal diffusivity is estimated to be 3%.

2.3. Specific Heat Capacity Measurements

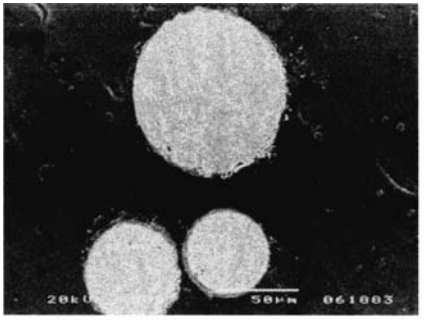
The specific heat capacity (C_p) was measured with a differential scanning calorimeter (DSC) using Perkin-Elmer Pyris 1 over a temperature range of 25 to 500°C. The measurements were carried out at a heating rate of $5\ \mathrm{K \cdot min^{-1}}$ in a nitrogen atmosphere with a flow rate of $30\ \mathrm{ml \cdot min^{-1}}$. The specific heat capacity was measured by using NIST synthetic sapphire, SRM 720 as a reference material. The standard deviation in the measurement of specific heat capacity is estimated to be 2%.

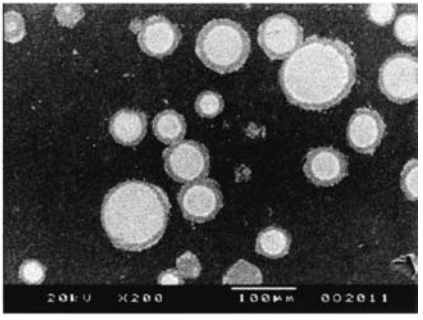
2.4. Calculation of the Thermal Conductivity

The thermal conductivity of U-Mo/Al dispersion fuels can be directly calculated from the following equation,

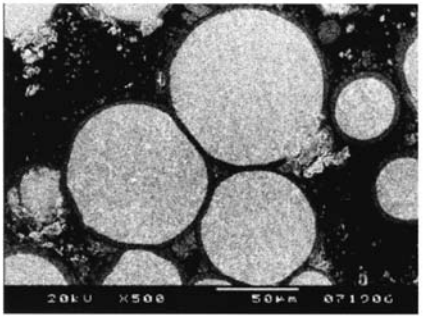
$$\lambda = \rho \alpha C_p \tag{1}$$

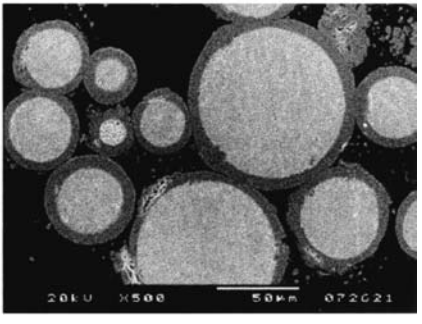
where ρ is the bulk density ($\mathrm{g \cdot cm^{-3}}$), α is the thermal diffusivity ($\mathrm{cm^2 \cdot s^{-1}}$), C_p is the specific heat capacity ($\mathrm{J \cdot g^{-1} \cdot K^{-1}}$), and λ is the thermal conductivity ($\mathrm{W \cdot m^{-1} \cdot K^{-1}}$). The density of the specimen is determined using the Archimedes method.



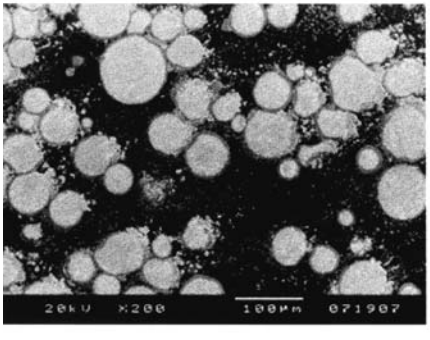


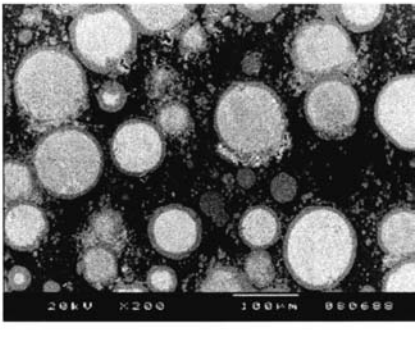
U-10 wt% Mo/Al(10 vol %): 525 °C 2h:2.09 μm, 8 h:5.36 μm





U-10 wt% Mo/Al(30 vol %): 525 °C 1h:3.0 μm, 10.5 h:6.26 μm





U-10 wt% Mo/Al(40 vol %): 525 °C 1h 20 min:2.74 μm, 12 h:5.86 μm

Fig. 1. SEM micrograph of U-10 wt% Mo/Al dispersion fuel with heat treatment time and thickness of reaction layer.

Table II. Experimental Results for the Thermal Diffusivity of U-10 wt% Mo/Al Dispersion Fuel

	Sample ($cm^2 \cdot s^{-1}$)							
T (°C)	U10M_1	U10M_2	U10M_3	U10M_4	U10M_5	U10M_6	U10M_7	U10M_8
22	0.743	0.749	0.725	0.539	0.463	0.335	0.286	0.259
100	0.709	0.732	0.702	0.522	0.452	0.355	0.291	0.268
200	0.701	0.725	0.684	0.526	0.454	0.336	0.299	0.266
300	0.694	0.705	0.669	0.515	0.443	0.330	0.289	0.264
400	0.683	0.690	0.654	0.508	0.439	0.318	0.283	0.256
500	0.637	0.654	0.617	0.489	0.424	0.304	0.272	0.239

3. RESULTS AND DISCUSSION

SEM micrographs of the U-Mo/Al dispersion fuels show the reaction layer thickness increasing with increasing heat treatment time. In Fig. 1, the matrix aluminium is the dark area, and the white spherical particle is the U-Mo alloy. The diameter of a U-Mo particle is about 50 to 70 μm. After annealing at 525°C, the matrix reacts completely to form (U-Mo)Al_x reaction layers. It is probable that the reaction layers impact thermal conduction in the fuel core.

The thermal conductivities of U-Mo/Al dispersion fuels over temperature ranges of 25 to 500°C are given in Table II to X. The thermal conductivity of U-Mo/Al dispersion fuels decreased with increasing volume

Table III. Experimental Results for the Specific Heat Capacity of U-10 wt% Mo/Al Dispersion Fuel

	Sample ($J \cdot g^{-1} \cdot K^{-1}$)							
T (°C)	U10M_1	U10M_2	U10M_3	U10M_4	U10M_5	U10M_6	U10M_7	U10M_8
26.3	0.6029	0.6470	0.6146	0.3293	0.3317	0.3416	0.2767	0.2737
52.4	0.6241	0.6652	0.6304	0.3383	0.3429	0.3541	0.2809	0.2792
101.7	0.6453	0.6878	0.6510	0.3446	0.3496	0.3695	0.2916	0.2856
151.7	0.6609	0.7043	0.6675	0.3606	0.3647	0.3748	0.2972	0.3017
202.3	0.6797	0.7189	0.6804	0.3625	0.3638	0.3768	0.3019	0.3007
252.2	0.6889	0.7318	0.6947	0.3684	0.3706	0.3772	0.3051	0.3051
301.9	0.7024	0.7465	0.7079	0.3753	0.3759	0.3836	0.3098	0.3113
352.0	0.7198	0.7620	0.7275	0.3837	0.3847	0.3880	0.3087	0.3149
401.9	0.7241	0.7699	0.7363	0.3899	0.3896	0.4093	0.3123	0.3186
451.7	0.7314	0.7835	0.7525	0.3968	0.3999	0.4026	0.3243	0.3264
501.3	0.7429	0.7913	0.7467	0.4028	0.4053	0.4096	0.3328	0.3375

Table IV. Calculated Results for the Thermal Conductivity of U-10 wt% Mo/Al Dispersion Fuel

	Sample ($W \cdot m^{-1} \cdot K^{-1}$)							
T (°C)	U10M_1	U10M_2	U10M_3	U10M_4	U10M_5	U10M_6	U10M_7	U10M_8
25	176.3	186.0	174.6	125.4	103.4	72.6	64.3	58.2
50	177.1	188.2	175.1	126.7	104.7	74.9	66.5	60.1
100	179.5	192.3	176.8	129.2	107.1	78.2	69.9	63.1
150	182.6	195.9	179.1	131.7	109.1	80.1	71.9	65.2
200	186.1	198.9	181.7	133.9	111.0	80.8	73.0	66.5
250	189.5	201.1	184.2	136.0	112.5	80.7	73.2	67.1
300	192.4	202.7	186.3	137.7	113.8	80.0	73.1	67.3
350	194.1	203.3	187.5	139.1	114.9	79.3	72.8	67.2
400	194.1	203.0	187.3	139.9	115.6	78.8	72.6	66.9
450	191.5	201.5	185.2	140.1	116.1	78.8	73.0	66.5
500	185.8	198.6	181.0	139.5	116.1	79.9	74.0	66.2

fraction of U-Mo particles. The literature values of the thermal conductivity of aluminium, uranium, and molybdenum are 237, 27.6, and 138 $W \cdot m^{-1} \cdot K^{-1}$ at room temperature, respectively [7]. The thermal conductivity of aluminium is larger than that for the U-Mo alloy. Uranium has a very small thermal conductivity. The increase in the thermal conductivity with fuel loading shows the same linear trend as observed for the specific heat capacity and thermal diffusivity. In previous results, the thermal conductivity of U-Mo/Al dispersion fuel samples decrease in a linear fashion up to 50 vol% [9]. Except for some abnormal data, the previous results show little deviation within $\pm 5\%$ to the ANL data [10]. The density for ANL samples were reported to be 10.06 and 8.29 $g \cdot cm^{-3}$ for TP2 and TP3,

Table V. Experimental Results for the Thermal Diffusivity of U-8wt% Mo/Al Dispersion Fuel

	Sample ($cm^2 \cdot s^{-1}$)				
T (°C)	U8M_1	U8M_2	U8M_3	U8M_4	U8M_5
22	0.695	0.591	0.370	0.290	0.251
100	0.697	0.581	0.376	0.307	0.256
200	0.685	0.564	0.360	0.291	0.262
300	0.668	0.563	0.355	0.302	0.258
400	0.666	0.543	0.340	0.296	0.245
500	0.626	0.513	0.326	0.276	0.230

Table VI. Experimental Results for the Specific Heat Capacity of U-8 wt% Mo/Al Dispersion Fuel

	Sample ($J \cdot g^{-1} \cdot K^{-1}$)				
T (°C)	U8M_1	U8M_2	U8M_3	U8M_4	U8M_5
26.3	0.5743	0.5725	0.3301	0.2808	0.2621
52.4	0.5846	0.5816	0.3371	0.2855	0.2673
101.7	0.6025	0.6005	0.3489	0.2957	0.2757
151.7	0.6178	0.6140	0.3553	0.3010	0.2818
202.3	0.6315	0.6267	0.3603	0.3066	0.2867
252.2	0.6442	0.6378	0.3658	0.3121	0.2918
301.9	0.6571	0.6483	0.3731	0.3197	0.2989
352.0	0.6705	0.6609	0.3819	0.3248	0.3035
361.3	–	–	0.3790	0.3221	–
381.1	–	–	0.3825	0.3291	–
401.9	0.6784	0.6681	0.3830	0.3276	0.3071
421.2	–	–	0.3893	0.3352	–
441.1	–	–	0.3952	0.3397	–
451.7	0.6869	0.6781	–	–	0.3138
461.0	–	–	0.3982	0.3399	–
480.8	–	–	0.4039	0.3517	–
501.3	0.6995	0.6811	0.4086	0.3478	0.3219

Table VII. Calculated Results for the Thermal Conductivity of U-8 wt% Mo/Al Dispersion Fuel

	Sample ($W \cdot m^{-1} \cdot K^{-1}$)				
T (°C)	U8M_1	U8M_2	U8M_3	U8M_4	U8M_5
25	166.7	136.5	85.7	82.4	57.3
50	169.0	137.4	87.5	84.0	58.9
100	173.3	139.5	90.0	86.3	61.7
150	177.1	141.7	91.4	87.8	63.9
200	180.3	144.0	92.0	88.5	65.3
250	183.0	146.1	92.1	88.7	66.2
300	184.8	147.7	91.9	88.7	66.6
350	185.9	148.6	91.6	88.7	66.6
400	186.0	148.6	91.6	88.8	66.1
450	185.0	147.2	92.0	89.3	65.4
500	182.8	144.2	93.1	90.5	64.3

Table VIII. Experimental Results for the Thermal Diffusivity of U-7 wt% Mo/Al Dispersion Fuel

	Sample ($cm^2 \cdot s^{-1}$)								
T (°C)	U7M_1	U7M_2	U7M_3	U7M_4	U7M_5	U7M_6	U7M_7	U7M_8	U7M_9
22	0.490	0.526	0.418	0.371	0.282	0.543	0.524	0.412	0.398
100	0.510	0.503	0.387	0.362	0.283	0.545	0.545	0.431	0.372
200	0.511	0.507	0.394	0.353	0.281	0.546	0.534	0.399	0.370
300	0.499	0.507	0.378	0.340	0.270	0.535	0.524	0.379	0.363
400	0.488	0.493	0.360	0.321	0.256	0.511	0.510	0.363	0.346
500	0.477	0.476	0.345	0.307	0.242	0.490	0.486	0.343	0.330

respectively. The thermal conductivity of U-Mo/Al at room temperature is given as 70 to 190 $W \cdot m^{-1} \cdot K^{-1}$ depending on the U-Mo volume fraction.

The thermal diffusivity, specific heat capacity, and thermal conductivity of heat-treated samples of U-Mo/Al dispersion fuels are reported in Table II to X. The thermal conductivities of heat-treated samples were much lower than as-extruded dispersion fuel core due to the reaction layer resulting from the reaction between the U-Mo fuel and the aluminium matrix. The thickness of aluminide layer formed at the U-Mo particle surface increases gradually in accordance with the reaction time.

Figures 2 and 3 show the thermal conductivity of U-Mo/Al dispersion fuel samples. The thermal conductivity of U-Mo/Al dispersion fuels increases with temperature. The thermal conductivities of U-10 wt% Mo/Al samples

Table IX. Experimental Results for the Specific Heat Capacity of U-7 wt% Mo/Al Dispersion Fuel

	Sample ($J \cdot g^{-1} \cdot K^{-1}$)								
T (°C)	U7M_1	U7M_2	U7M_3	U7M_4	U7M_5	U7M_6	U7M_7	U7M_8	U7M_9
25.9	0.3244	0.3232	0.3207	0.3229	0.3266	0.3283	0.3237	0.3300	0.3271
51.8	0.3338	0.3309	0.3281	0.3311	0.3342	0.3389	0.3302	0.3370	0.3368
101.6	0.3432	0.3403	0.3382	0.3413	0.3437	0.3493	0.3401	0.3470	0.3470
151.7	0.3506	0.3483	0.3461	0.3495	0.3521	0.3577	0.3485	0.3546	0.3546
201.8	0.3582	0.3560	0.3525	0.3564	0.3586	0.3660	0.3585	0.3609	0.3609
251.6	0.3650	0.3627	0.3594	0.3628	0.3648	0.3728	0.3604	0.3672	0.3662
301.7	0.3740	0.3666	0.3647	0.3689	0.3709	0.3791	0.3699	0.3731	0.3717
351.7	0.3824	0.3829	0.3676	0.3750	0.3766	0.3818	0.3770	0.3794	0.3810
401.5	0.3892	0.3823	0.3834	0.3851	0.3890	0.3863	0.3828	0.3840	0.3878
451.4	0.3957	0.3992	0.4024	0.3973	0.4053	0.4078	0.4017	0.4091	0.4038
501.2	0.4040	0.4145	0.4027	0.4055	0.4118	0.4262	0.4081	0.4111	0.4088

Table X. Calculated Results for the Thermal Conductivity of U-7 wt% Mo/Al Dispersion Fuel

	Sample ($W \cdot m^{-1} \cdot K^{-1}$)								
T (°C)	U7M_1	U7M_2	U7M_3	U7M_4	U7M_5	U7M_6	U7M_7	U7M_8	U7M_9
25	116.1	121.3	89.4	78.0	55.0	128.1	120.7	87.8	86.1
50	119.7	122.2	89.6	79.1	56.5	132.2	124.1	90.0	86.3
100	125.6	124.3	89.9	80.5	58.4	138.2	129.5	92.8	86.6
150	129.8	126.3	90.0	81.4	59.6	141.8	133.1	93.8	87.2
200	132.6	128.6	89.8	81.6	60.1	143.6	135.4	93.4	87.8
250	134.3	131.0	89.1	81.6	60.2	144.1	136.6	92.2	88.5
300	135.3	133.5	87.8	81.3	60.0	144.1	137.3	90.6	89.2
350	135.9	135.9	85.8	81.0	59.8	144.1	137.6	89.2	89.9
400	136.5	138.1	82.7	80.8	59.6	144.7	138.2	88.4	90.3
450	137.6	139.8	78.6	80.8	59.7	146.4	139.2	88.9	90.3
500	139.6	140.8	73.3	81.0	60.1	149.7	141.1	91.1	89.8

exhibit a very similar trend within 60 to 200 $W \cdot m^{-1} \cdot K^{-1}$ independent of the volume fraction of U-Mo. The thermal conductivity of U-8 wt% Mo/Al is shown in Fig. 3. These data show little lower values than for U-10 wt% Mo/Al, because of the U-Mo volume fraction. Thermophysical properties of U-Mo/Al dispersion fuels depend on the density of samples.

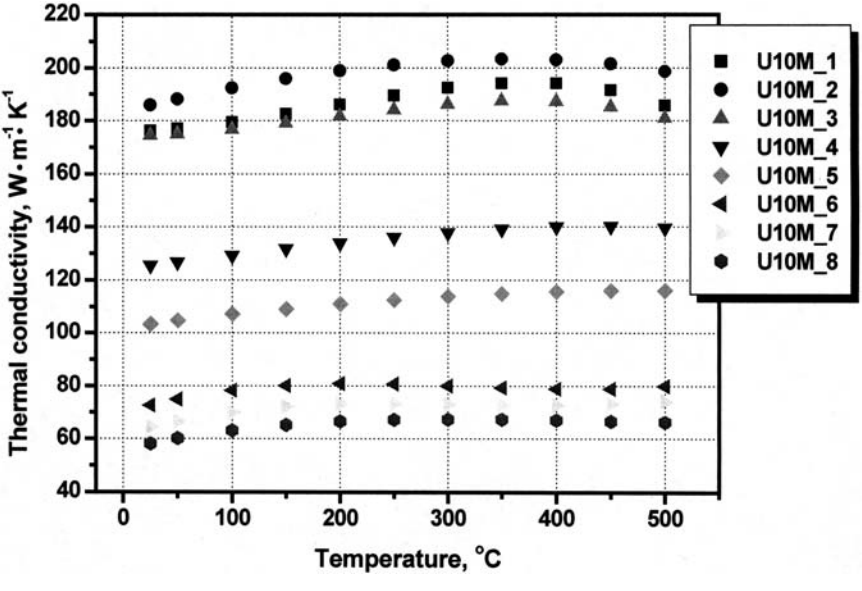


Fig. 2. Thermal conductivity of U-10 wt% Mo/Al dispersion fuel.

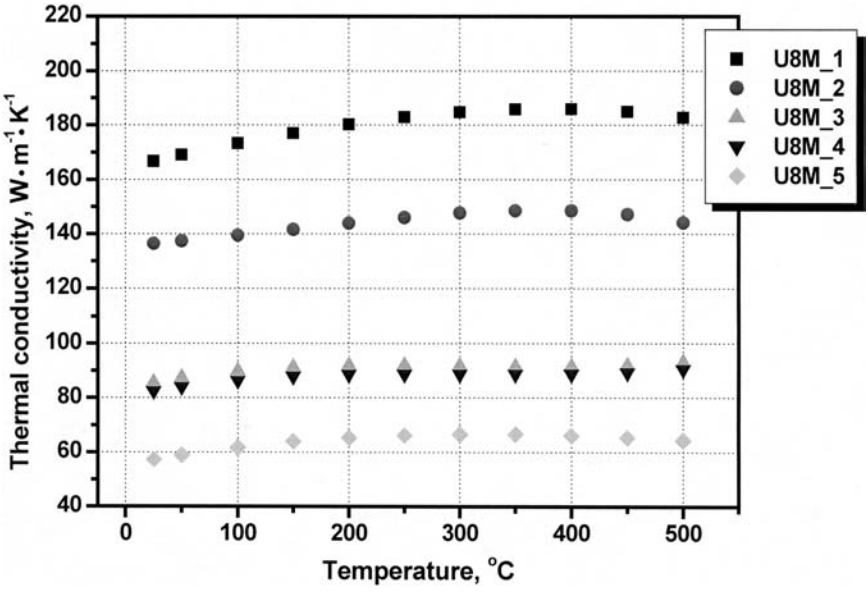


Fig. 3. Thermal conductivity of U-8 wt% Mo/Al dispersion fuel.

Figures 4 to 9 show the volume fraction dependence on thermal diffusivity, specific heat capacity, and thermal conductivity of U-Mo/Al dispersion fuels. Thermophysical properties depend on the volume fraction of the U-Mo alloy. The specific heat capacity is clearly different with each volume fraction over each temperature range. The thermal conductivity of U-Mo/Al dispersion fuels increases as the U-Mo volume fraction increases. The uranium loading density influences the thermal conduction of U-Mo/Al dispersion fuel. It is important to understand the dependence of the thermophysical properties on the volume fraction of the U-Mo alloy.

Figure 10 shows the dependence of the thermal conductivity on heat treatment time for U-10 wt% Mo/Al dispersion fuel. The thermal conductivity varies inversely with the heat treatment time. The thermal conductivity abruptly decreases for short heat treatment times, but it slowly decreases with longer heat treatment times. Similarly, Fig. 11 shows the dependence of the thermal conductivity on heat treatment time for U-8 wt% Mo/Al dispersion fuel.

The thermal conductivity of U-Mo/Al dispersion fuels vary with the volume fraction of a reaction layer as shown in Figs. 12 and 13. The volume fractions of a reaction layer were calculated using the SEM micrograph, and the thermal conductivity varies inversely with the volume

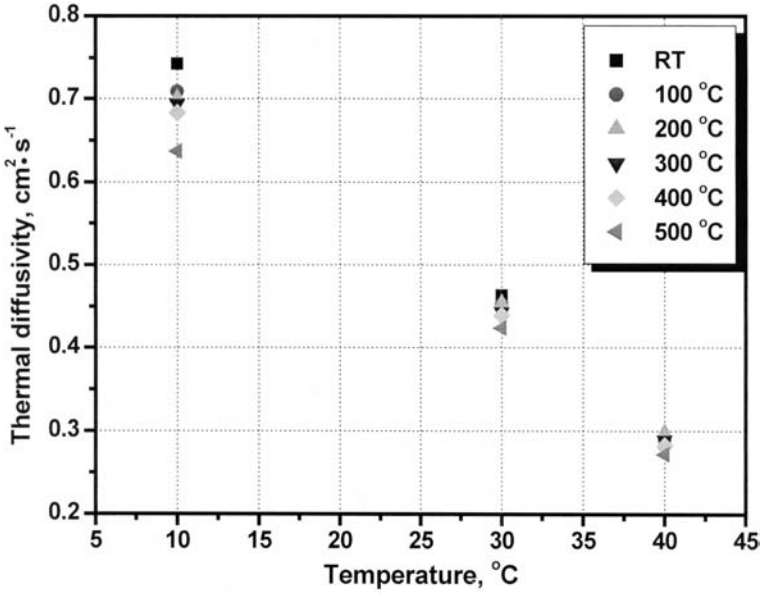


Fig. 4. Thermal diffusivity of U-10 wt% Mo/Al dispersion fuel.

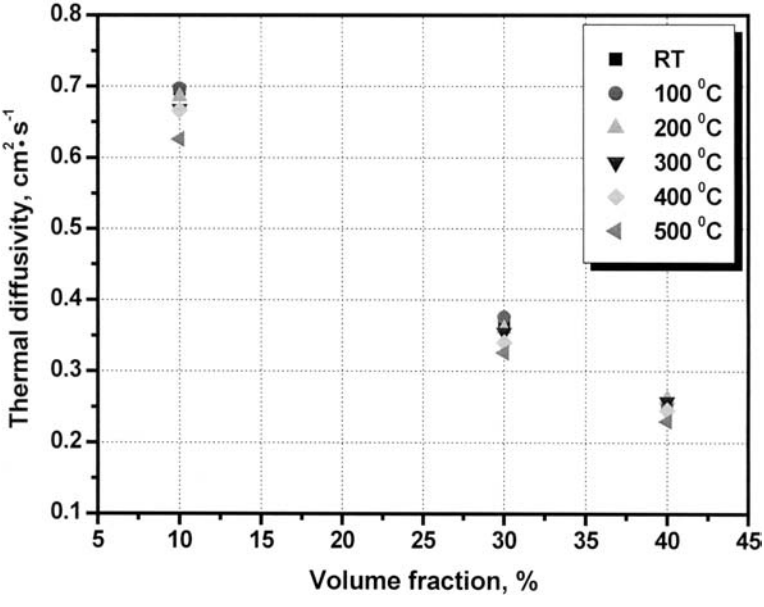


Fig. 5. Thermal diffusivity of U-8 wt% Mo/Al dispersion fuel.

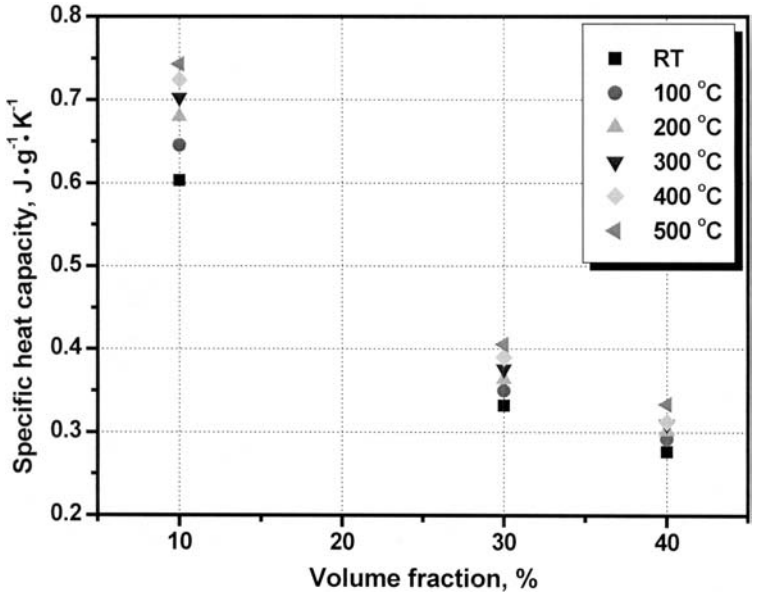


Fig. 6. Specific heat capacity of U-10 wt% Mo/Al dispersion fuel.

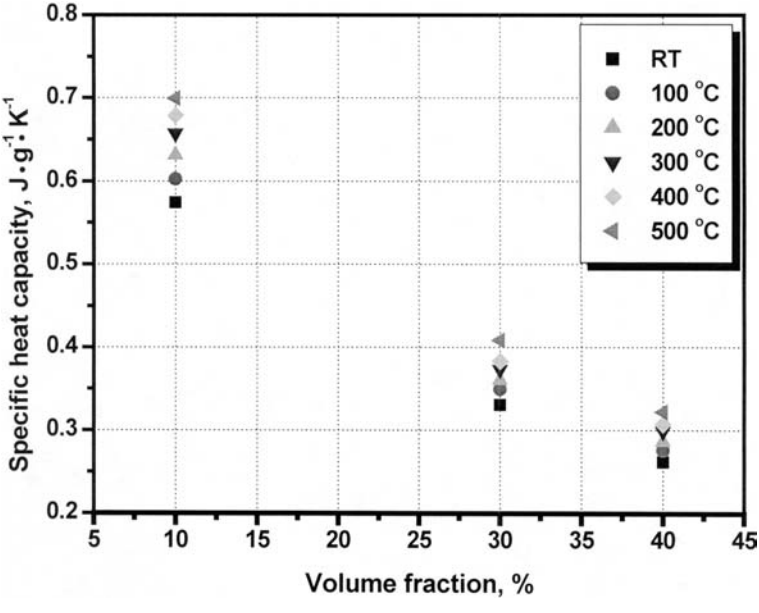


Fig. 7. Specific heat capacity of U-8 wt% Mo/Al dispersion fuel.

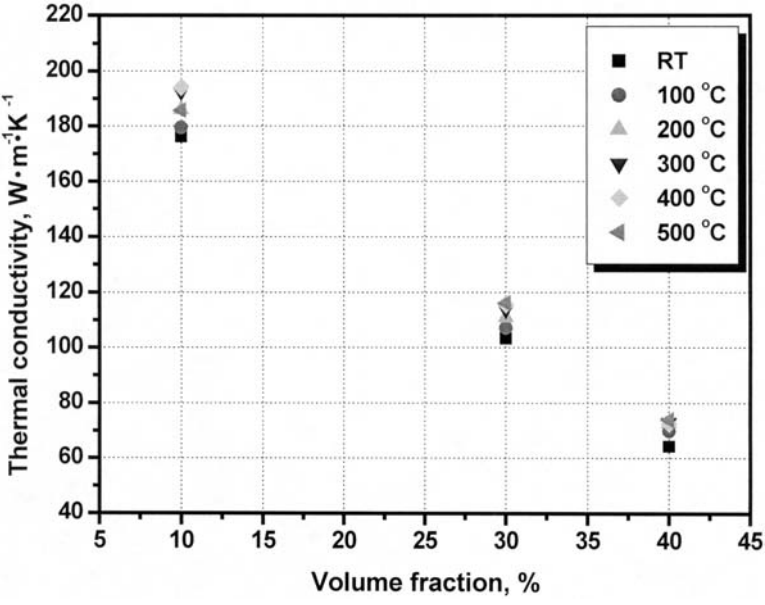


Fig. 8. Thermal conductivity of U-10 wt% Mo/Al dispersion fuel.

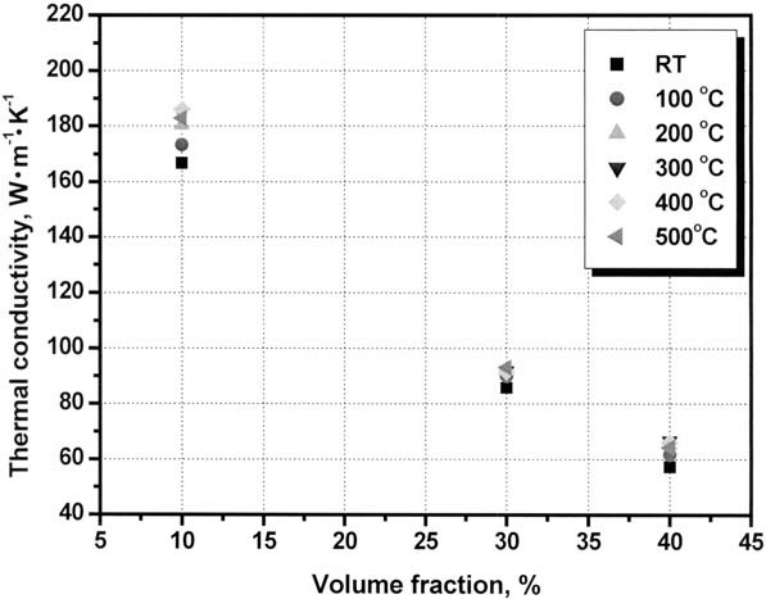


Fig. 9. Thermal conductivity of U-8 wt% Mo/Al dispersion fuel.

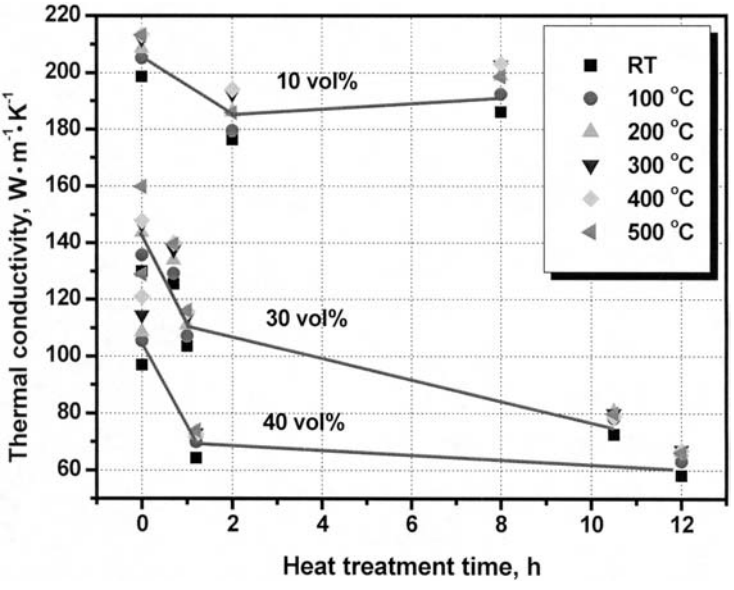


Fig. 10. Variation of thermal conductivity of U-10 wt% Mo/Al dispersion fuel with heat treatment time.

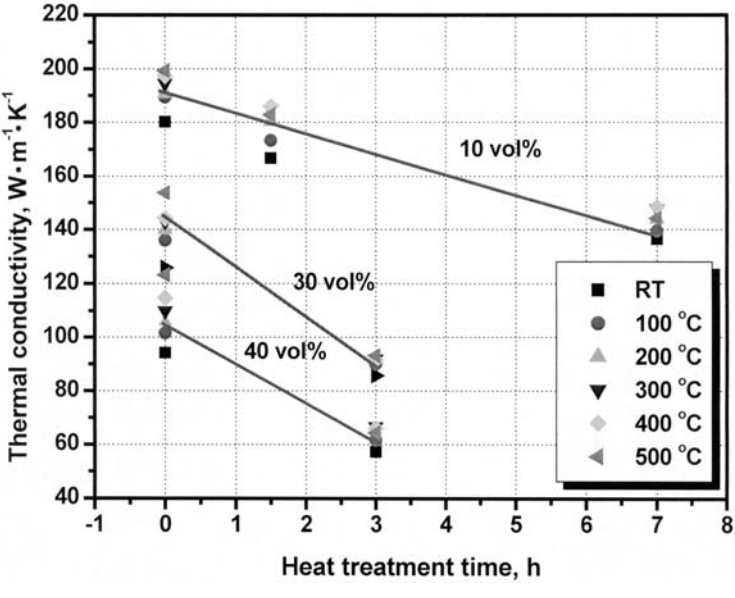


Fig. 11. Variation of thermal conductivity of U-8 wt% Mo/Al dispersion fuel with heat treatment time.

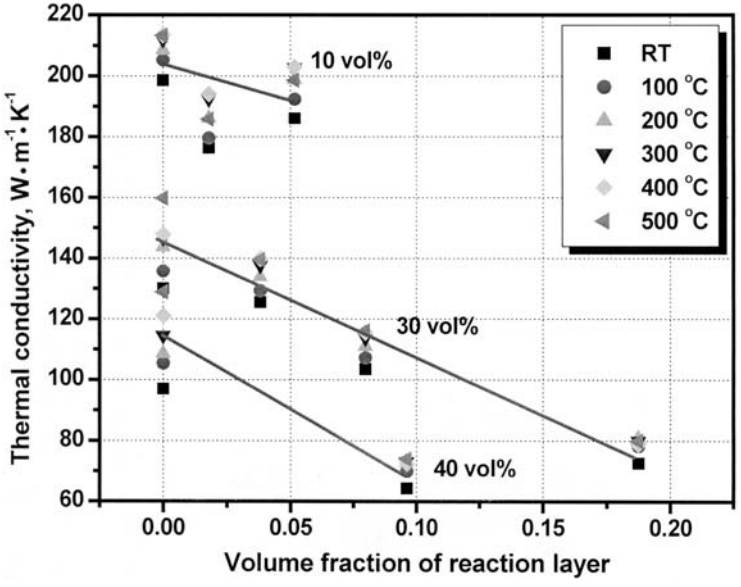


Fig. 12. Variation of thermal conductivity of U-10 wt% Mo/Al dispersion fuel with volume fraction of reaction layer.

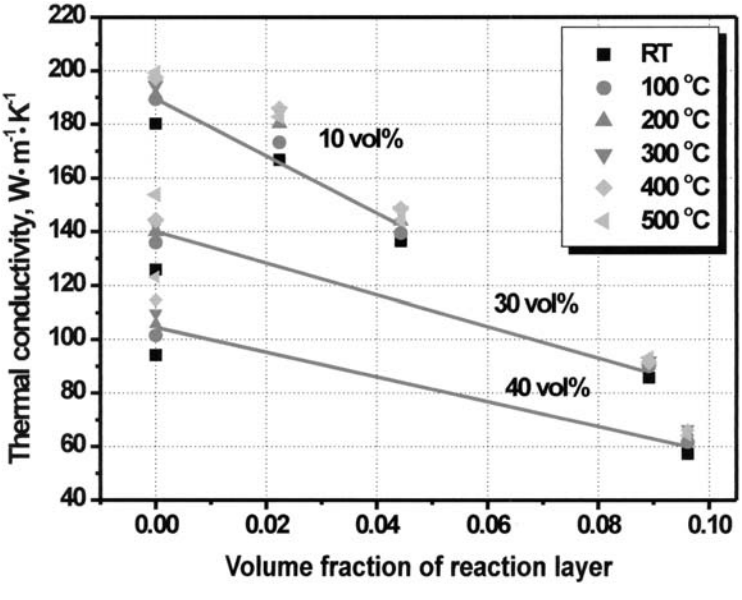


Fig. 13. Variation of thermal conductivity of U-8 wt% Mo/Al dispersion fuel with volume fraction of reaction layer.

fraction. The volume fraction of the reaction layer influences the thermal conduction.

4. CONCLUSIONS

The effect of heat treatment for U-Mo/Al was investigated by measurements of the thermal diffusivity, specific heat capacity, and density of U-Mo/Al dispersion fuels at temperatures ranging from room temperature to 500°C. Based on these data, thermal conductivities of U-Mo/Al dispersion fuels were calculated. The thermal conductivity of U-Mo/Al dispersion fuels decreased with an increase in the volume fraction of U-Mo particles. The results clearly show that the thermophysical properties are very sensitive to the heat treatment time. The composition of a reaction layer is (U-Mo)Al_x. Therefore, the themal conductivity of U-Mo/Al dispersion fuels decreases as the volume fraction of reaction layer increases.

The thermophysical properties data of U-Mo dispersion fuel core can be used for fuel and reactor design. These data are very useful for estimation of the fuel temperature during reactor operation. Thermal conductivity measurements, based on several temperatures could be used to estimate the temperature of the irradiation fuels and could lead to a better understanding of the effect of annealing parameters.

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