



The experimental determination of thermophysical properties of intermetallic CuAl_2 phase in equilibrium with (Al + Cu + Si) liquid



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ABSTRACT

The equilibrated grain boundary groove shapes of solid CuAl_2 in equilibrium with (Al + Cu + Si) eutectic liquid were observed from a quenched sample by using a radial heat flow apparatus. The Gibbs–Thomson coefficient, (solid + liquid) interfacial energy and grain boundary energy of the solid CuAl_2 were determined from these observed shapes. The thermal conductivity of the eutectic solid and the thermal conductivity ratio of eutectic liquid to the eutectic solid in the (Al + 26.82 wt.% Cu + 5.27 wt.% Si) eutectic alloy at its eutectic melting temperature were also measured with a radial heat flow apparatus and a Bridgman-type growth apparatus, respectively. The three phases of (Al + Cu + Si) alloy have detected as Al solution, Si and θ (CuAl_2) phases with EDX composition analysis and the microstructure of these phases were photographed by SEM.

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1. Introduction

Aluminium based alloys have many advantages such as high specific strength, high thermal and electrical conductivities, low density, reasonable corrosion resistance and ease of casting. Aluminium alloys have a wide range of applications in the aerospace and automotive industries [1,2]. (Al + Cu + Si) alloy is one of the most important aluminium based alloys. It has superior properties such as strength and corrosion resistance. The strength of (Al + Cu + Si) ternary alloy is higher than (Al + Si) binary alloy and the corrosion resistance is better than (Al + Cu) binary alloy [3]. (Al + Cu + Si) system is mostly used in automotive industry and is preferred in many technological fields due to its lightweight, low density, good thermal and electrical conductivity. The eutectic composition of (Al + Cu + Si), due to its low melting point and uniform structure, provides many advantages such as brazing and soldering application [1,4].

Although a lot of research has been carried out on (Al + Cu + Si) non-eutectic alloy [5–7], a few studies have been done on the ternary eutectic (Al + Cu + Si) alloy systems [8,9]. To understand better the characteristics of the (Al + Cu + Si) ternary alloy system is crucial for specific applications and better material designing. From

the (Al + Cu + Si) phase diagram [4], the eutectic composition of (Al + Cu + Si) alloy is (Al + 26.82 wt.% Cu + 5.27 wt.% Si) (Al + 13.5 at.% Cu + 6.0 at.% Si) and the eutectic temperature is $T = 795$ K. There are three different phases of (Al + Cu + Si) eutectic alloy, which are Al solution, Si and θ (CuAl_2). In our previous work [10] the thermophysical properties of (Al + Cu + Si) ternary eutectic alloy have determined for solid Al solution phase. While in that study thermophysical properties of Al phase have investigated, in this work some thermophysical properties of CuAl_2 phase of (Al + Cu + Si) such as thermal conductivity of the solid and liquid phases, Gibbs–Thomson coefficient (Γ), (solid + liquid) interfacial energy (σ_{SL}) and grain boundary energy (σ_{gb}) for solid CuAl_2 in equilibrium with (Al + Cu + Si) eutectic liquid have determined.

2. Materials and methods

2.1. Sample production

The composition of the alloy system was determined as (Al + 26.82 wt.% Cu + 5.27 wt.% Si) [4] to grow a single solid CuAl_2 on the eutectic casting phase. The (Al + 26.82 wt.% Cu + 5.27 wt.% Si) was produced by using Al, Cu and Si metals, having 0.999, 0.999 and 0.99999 mass fraction purities, respectively in a vacuum furnace. Alloying metals purchased from Alfa Easer Company and used without any purification. Specification of materials used in

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this work is listed in [table 1](#). The molten alloy was spilled into a graphite crucible at the casting furnace and then directionally solidified. Now the sample is ready to place in the radial heat flow apparatus.

An experimental system was firstly designed by Gündüz and Hunt to obtain the grain boundary groove shapes (GBGS) in metallic alloy systems [11]. The details of the experimental technique are given in [11–16].

2.2. Determination of microstructure of (Al + Cu + Si) alloy

The quantitative chemical composition analysis of quenched ternary eutectic liquid and CuAl_2 solid phase was determined by using an Energy Dispersive X-ray analyser (EDX) and the results are given in [figure 1](#). The copper and silicon's solid solubility in solid aluminium are (5.7 and 0.83) wt.% at their melting temperatures of $T = (821 \text{ and } 844) \text{ K}$, respectively in the (Al + Cu) and

(Al + Si) systems [17]. According to EDX results as shown in [figure 1](#) and the solubility of components in each phase, solid phase is exactly CuAl_2 phase and the liquid composition is close to the casting of (Al + 26.82 wt.% Cu + 5.27 wt.% Si) (Al + 13.5 at.% Cu + 6.0 at.% Si) eutectic alloy.

EDX composition analysis was also used to determine the three phases of (Al + Cu + Si) alloy. As shown in [figure 2](#), the black phase is Al solution, the grey phase is Si and the white phase is $\theta (\text{CuAl}_2)$. We have obtained the compositions of (Al + Cu + Si) alloy for Al solution phase as 95.58 at.% Al, 2.79 at.% Cu and 1.63 at.% Si, for Si phase as 100 at.% Si and for $\theta (\text{CuAl}_2)$ phase as 66.38 at.% Al, 31.34 at.% Cu and 2.28 at.% Si, as shown in [figure 2](#). In the phase analysis of (Al + Cu + Si) alloy system which was carried out by Ponveiser *et al.* [4] the compositions of phases was found 96 at.% Al, 2.5 at.% Cu and 1.5 at.% Si for Al solution phase, 100 at.% Si for Si phase, 68 at.% Al, 31 at.% Cu and 1 at.% Si for $\theta (\text{CuAl}_2)$ phase. The results of Ponveiser *et al.* [4] are in good agreement with this study.

TABLE 1

Specifications of materials used in this study.

Material names	Source	CAS number	Properties	Mass fraction purity	Purification method
Al	Alfa Aesar	7429-90-5	Aluminium shot irregular 15 mm and down	0.999 (metal basis)	No further purification
Cu	Alfa Aesar	7440-50-8	Copper shot 1 to 10 mm (0.04 to 0.4 in)	0.999 (metal basis)	No further purification
Si	Alfa Aesar	7440-21-3	Silicon lump 15 cm (5.9 in) and down	0.99999+ (metal basis)	No further purification

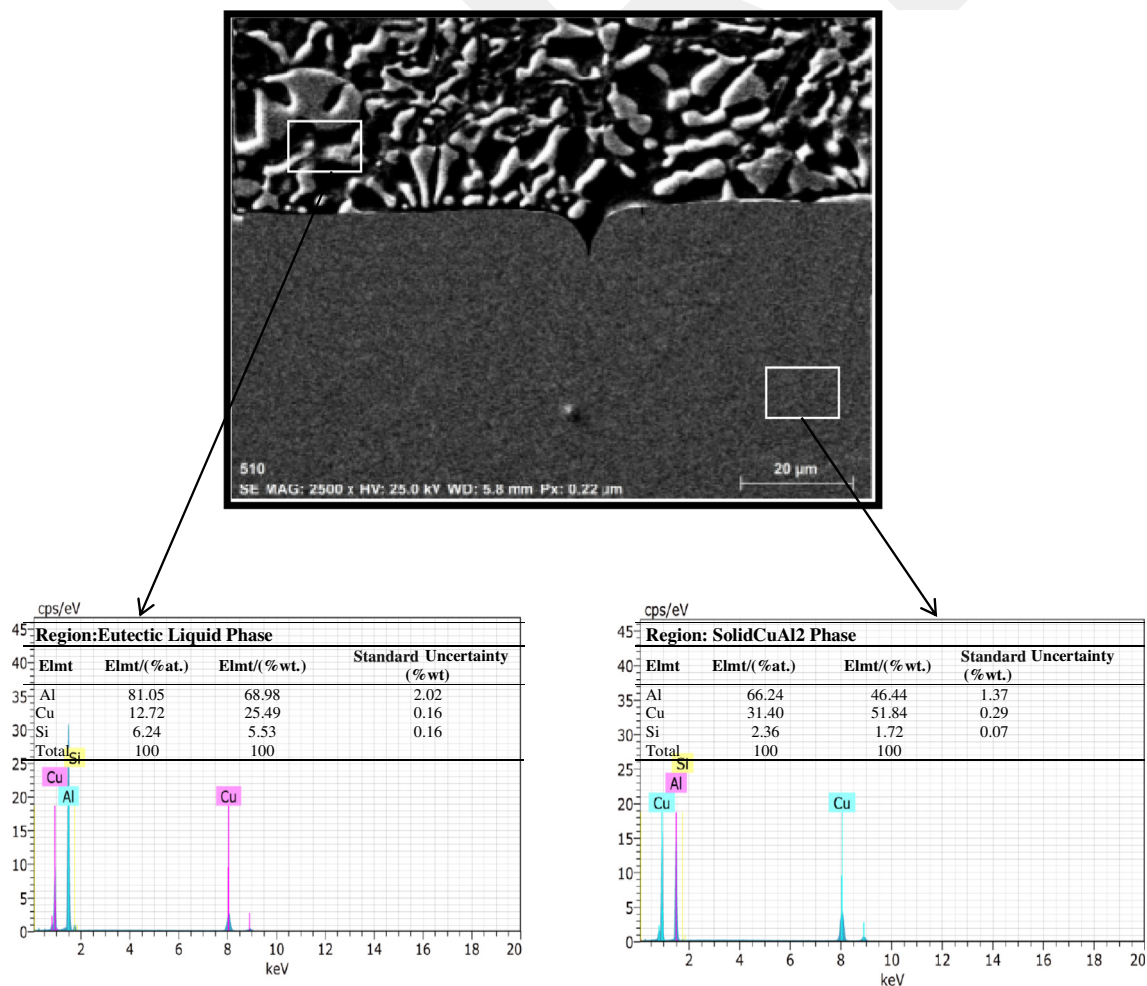


FIGURE 1. The chemical composition analysis of the solid CuAl_2 in equilibrium with the (Al + Cu + Si) eutectic liquid by using EDX at the $T = 298 \text{ K}$ temperature.

2.3. Determination of the coordinates of GBGS

The samples which have the GBGSs were cut transversely and ground flat with SiC paper. Firstly, polishing was carried out by a standard method and then the samples were etched with 2.5 mL nitric acid (w/w 65%), 1.5 mL hydrochloric acid (w/w 37%), 1 mL hydrofluoric acid (w/w 40%) in 95 mL water (15 s).

The equilibrated GBGSs were photographed via an Olympus DP12 type CCD camera and an Olympus BX51 type light optical microscope. The photograph of a graticule ($200 \cdot 0.01 = 2$ mm) was taken with the same system. In order to measure the groove coordinates accurately, these two photographs were superimposed on one another. The accurate coordinates of the equilibrated GBGSs were measured to an accuracy of $\pm 10 \mu\text{m}$, by using Maraşlı and Hunt's geometrical method [18].

2.4. Thermal conductivity measurement for solid and liquid phases

In this study, radial heat flow apparatus has been used to measure the thermal conductivity of solid (Al + 26.82 wt.% Cu + 5.27 wt.% Si). The details of measurement system and procedure can be found in references [14,15].

The temperature gradient of the solid phase at the steady-state condition, is given by Fourier's law

$$G_s = \left(\frac{dT}{dr} \right)_s = -\frac{Q}{2\pi r \ell K_s}, \quad (1)$$

where Q is the total electrical power on the sample, r is the distance of the (solid + liquid) interface to the centre of the sample, ℓ is the length of the heating wire and K_s is the thermal conductivity of solid phase. Integration of the equation (1) gives

$$K_s = a_0 \frac{Q}{T_1 - T_2}, \quad (2)$$

where $a_0 = \ln(r_2/r_1)/2\pi\ell$ is an experimental constant, ℓ is the length of the central heating wire, T_1 and T_2 are the temperatures at r_1 and r_2 ($r_2 > r_1$). In order to determine the values of K_s , one has to measure the values of Q , r_1 , r_2 , ℓ , T_1 and T_2 .

The larger temperature gradient is necessary to increase the sensitivity in the measurement of thermal conductivity. A cylindrical sample was heated by using a Kanthal A-1 heating wire (12 to 14 cm lengths and 1.7 mm in diameter) from the centre and the outside of the specimen was kept cool by using a circulating system to get a radial temperature gradient as shown in figure 3. Eurotherm 2604 type controller was used to control the temperature of the specimen with an accuracy of ± 0.01 K and the temperature of the fluid in the cooling jacket was held at constant temperature by a Poly Science digital 9102 model circulating system.

The temperature of the sample was hold at constant temperature for at least two hours for every measuring temperature. At steady state, Hewlett Packard 34401 type multimeter and a data-logger were used to measure the total electrical power and the fixed thermocouples' temperature, respectively. The temperatures of the sample were measured by K-type thermocouples with 0.5 mm in diameter. During the experimental measurements, the specimen was kept in a slightly positive pressure of argon to prevent graphite erosion and oxidation. The determination of the thermal conductivity has been made both in heating and cooling steps in order to verify the measurement values.

The thermal conductivity of the solid (Al + 26.82 wt.% Cu + 5.27 wt.% Si) versus temperature is plotted in figure 4(a). The determined values of K_s for solid CuAl₂ are given in table 2. The thermal conductivities of pure Cu, Al and Si [19] are also given in figure 4(a). The value of K_s for the (Al + Cu + Si) eutectic solid at the eutectic temperature was obtained to be $90.57 \text{ W} \cdot \text{K}^{-1} \cdot \text{m}^{-1}$, by using the line in figure 4(a).

In our experimental system to measure the thermal conductivity of the liquid phase, a thick liquid layer is needed. Because of this thick liquid that causes convection, this method could not be used. K_L can be determined by the help of the K_s and the thermal conductivity ratio of the liquid phase to the solid phase ($R = K_L/K_s$). The R value can be measured with a Bridgman-type growth apparatus and the details of the experimental system are given in references [11–13,15].

The R value of the eutectic liquid to the eutectic solid was measured to be 0.70, as shown in figure 4(b). The K_s value of (Al + Cu + Si) eutectic solid was also measured to be $90.57 \text{ W} \cdot \text{K}^{-1} \cdot \text{m}^{-1}$.

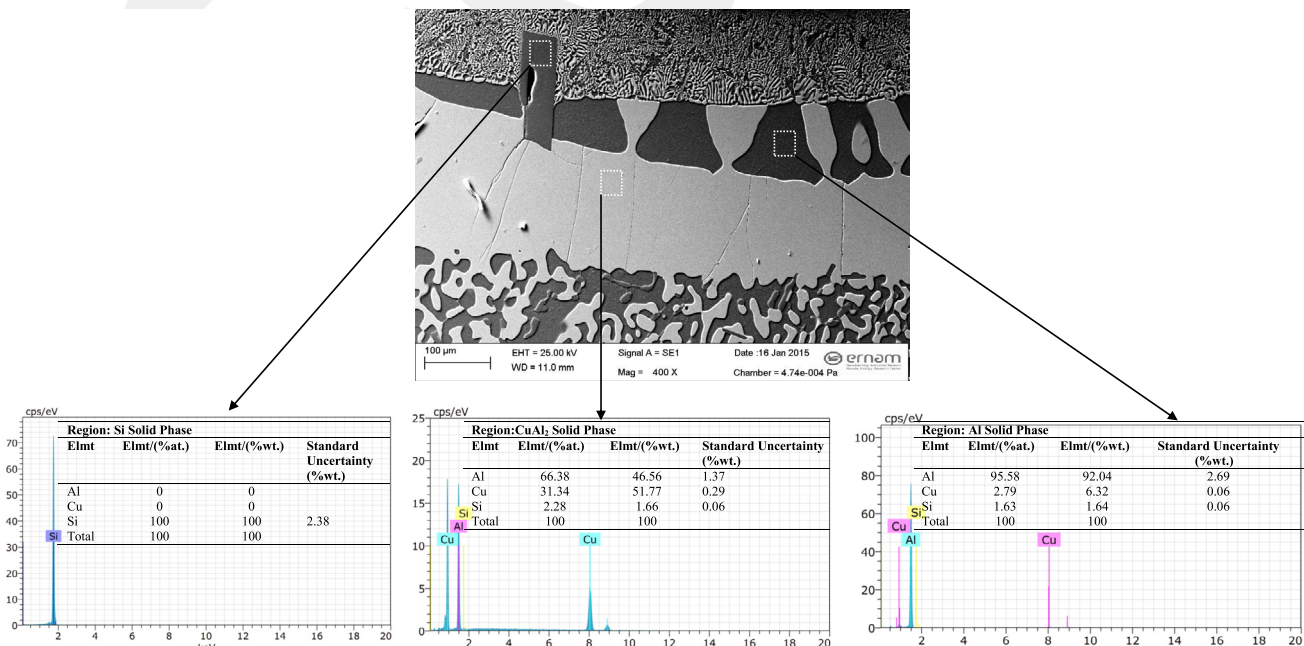


FIGURE 2. EDX analysis and SEM photograph of microstructural morphologies of (Al + Cu + Si) ternary eutectic alloy at the $T = 298$ K temperature.

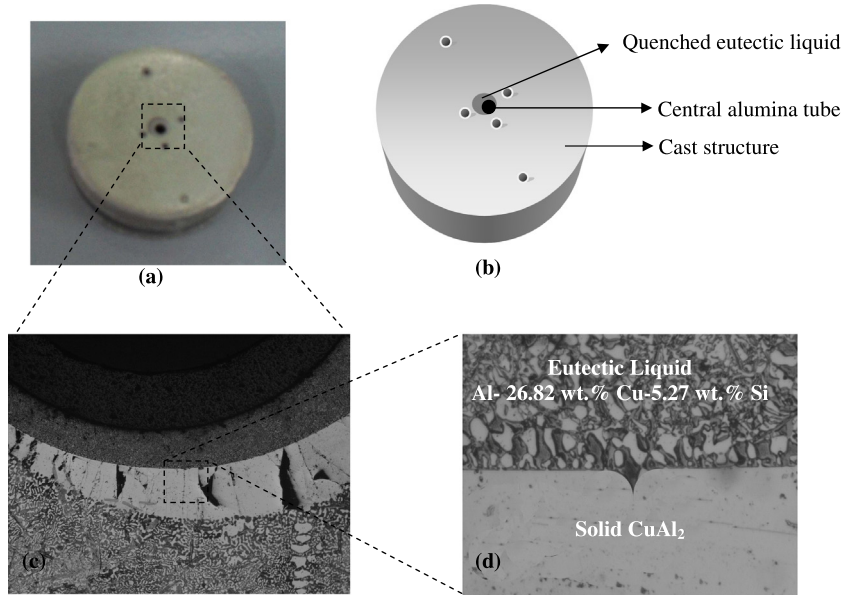


FIGURE 3. (a) The view of the transverse section of sample, (b) schematic representation of sample, (c) (solid + liquid) interface on sample, (d) typical grain boundary groove shape for solid CuAl_2 in equilibrium with the (Al + 26.82 wt.% Cu + 5.27 wt.% Si) eutectic liquid.

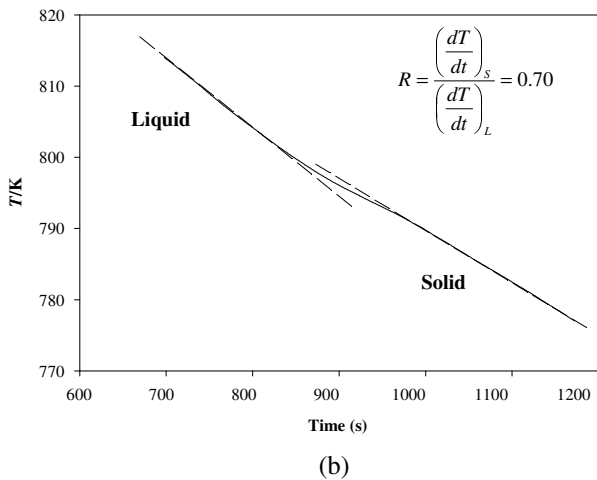
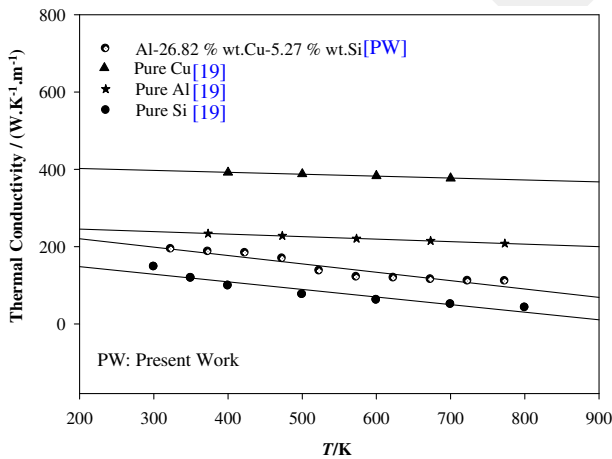


FIGURE 4. (a) Thermal conductivity of eutectic solid versus temperature in (Al + Cu + Si) system. (b) the cooling rate of eutectic (Al + 26.82 wt.% Cu + 5.27 wt.% Si) system.

TABLE 2

Experimental values of thermal conductivity variations with temperature at pressure $p = 0.1$ MPa for (Al + 26.82 wt.% Cu + 5.27 wt.% Si) eutectic composition (x) which consist of Al solution phase, Si phase and θ (CuAl_2) phase.^a The specimen was kept in a slightly positive pressure of argon.

T /(K)	Thermal conductivity/($\text{W} \cdot \text{K}^{-1} \cdot \text{m}^{-1}$)
323	193.70
373	187.27
423	183.48
473	169.34
523	137.38
573	121.22
623	119.08
673	115.21
723	111.06
773	110.90

^a Standard uncertainties are $u(T) = \pm 0.01$ K, $u(K_K) = \pm 0.4$ $\text{W} \cdot \text{K}^{-1} \cdot \text{m}^{-1}$, $u(x) = \pm 0.002$ and $u(p) = \pm 10$ kPa.

By using the values of R and K_S , the thermal conductivity of eutectic liquid was then determined to be $63.40 \text{ W} \cdot \text{K}^{-1} \cdot \text{m}^{-1}$. The K_S value of solid CuAl_2 phase at the equilibrium temperature of 821 K was determined by Gündüz and Hunt [11] as $108.7 \text{ W} \cdot \text{K}^{-1} \cdot \text{m}^{-1}$. Thus, by using the values of $K_{L(\text{ternary eutectic liquid})}$ and $K_{S(\text{CuAl}_2)}$, the R value of the equilibrated eutectic liquid phase to the solid CuAl_2 phase, $R = K_{L(\text{ternary eutectic liquid})}/K_{S(\text{CuAl}_2)}$, is also found to be 0.58.

As shown in table 3, the values of K_S and K_L for the CuAl_2 phase in (Al + Cu + Si) alloy system, which is obtained in the present work, have been compared with the values of K_S and K_L in the (Al + Cu) and (Al + Cu + Ag) systems obtained in previous works [11,20,21]. As seen on table 3, the values of K_S and K_L for CuAl_2 , which were obtained from the present work, agree with the values of K_S and K_L in previous works [11,20,21].

2.5. Measurement of temperature gradient in the solid phase

In order to determine Gibbs–Thomson coefficient (Γ) from the numerical method firstly constructed by Gündüz and Hunt [11], the temperature gradient of the solid phase (G_S) has to be determined for every GBGS. To determine the G_S value from equation (1), one must measure the Q , ℓ , r and the value of K_S for solid CuAl_2

TABLE 3Thermal conductivities of solid and liquid phases and their ratios at their eutectic temperatures for binary and ternary alloys at pressure $p = 0.1$ MPa.^a

Alloy	Phases	Melting temperature/(K)	$K/(W \cdot K^{-1} \cdot m^{-1})$	$R = K_L/K_S$
(Al + Cu + Si)	Eutectic Liquid (Al + 13.5 at.% Cu + 6.0 at.% Si)	795 [4]	63.40 [PW]	0.70 **
	Eutectic solid (Al + 13.5 at.% Cu + 6.0 at.% Si)		90.57 *** [PW]	
	Eutectic liquid (Al + 13.5 at.% Cu + 6.0 at.% Si)		63.40 [PW]	
	Solid CuAl ₂		108.70 [11]	
(Al + Cu)	Liquid (Al + 17.30 at.% Cu)	821 [11]	58.10 [11]	0.535
	Solid CuAl ₂ (Al + 31.94 at.% Cu)		108.70 [11]	
(Al + Cu + Ag)	Eutectic liquid (Al + 16.57 at.% Ag + 11.87 at.% Cu)	775.09 [22]	55.36 [20]	0.50
	Solid CuAl ₂ (Al + 32.31 at.% Cu + 0.04 at.% Ag)		110.64 [20]	
	Eutectic liquid (CuAl ₂ + 23.26 at.% Ag ₂ Al)	799.35 [22]	42.00 [21]	
	Solid CuAl ₂ (Al + 32.31 at.% Cu + 0.04 at.% Ag)		112.25 [21]	

^{*} Calculated value.^{**} Measured value.^{***} Extrapolated value.^a Standard uncertainties are $u(K) = \pm 0.4 W \cdot K^{-1} \cdot m^{-1}$, $u(x) = \pm 0.002$ and $u(p) = \pm 10$ kPa.**TABLE 4**The Gibbs–Thomson coefficients for solid CuAl₂ in equilibrium with the (Al + Cu + Si) eutectic liquid at pressure $p = 0.1$ MPa.^a The subscripts LHS and RHS refer to left hand side and right hand side of the groove respectively.

Groove No.	$G_S \cdot 10^2/(K \cdot m^{-1})$	Gibbs–Thomson coefficient	
		$\Gamma_{LHS} \cdot 10^{-8}/(K \cdot m)$	$\Gamma_{RHS} \cdot 10^{-8}/(K \cdot m)$
1	17.42	5.20	5.30
2	23.81	5.78	5.39
3	22.83	5.92	5.65
4	17.45	5.71	5.26
5	17.32	5.75	5.51
6	23.46	5.49	5.54
7	20.14	5.52	5.68
8	22.85	5.81	5.77
9	22.88	5.85	5.46
10	22.93	5.68	5.57
		$\Gamma = (5.59) \cdot 10^{-8} K \cdot m$	

^a Standard uncertainties are $u(G_S) = 0.1 K \cdot m^{-1}$, $u(\Gamma) = \pm 0.045 \cdot 10^{-8} K \cdot m$ and $u(p) = \pm 10$ kPa.

phase. The total standard uncertainty in the temperature gradient measurement is given in table 4.

2.6. Determination of entropy of fusion

The entropy change per unit volume for an alloy is given by Gündüz and Hunt [11], Christian [23],

$$\Delta S_f = \frac{RT_M}{m_L V_S} \frac{C_S - C_L}{(1 - C_L) C_L}, \quad (3)$$

where T_M is the melting temperature, V_S is the molar volume of solid phase, R is the gas constant, m_L is the liquidus slope, C_S and C_L are the solid and liquid compositions. The standard uncertainty in the determination of ΔS_f is about 5% [24].In present work, it was not possible to determine the value of entropy of fusion per unit volume for solid phase in the ternary eutectic system from equation (3). For two different temperatures T_1 and T_2 at a constant pressure, the entropy of fusion per unit volume can be written as

$$\Delta S_{f1} = \frac{\Delta q_1}{T_1}, \quad (4)$$

$$\Delta S_{f2} = \frac{\Delta q_2}{T_2}, \quad (5)$$

where Δq_1 and Δq_2 are the absorbed or emitted heat (enthalpy of fusion or solidification) at the melting temperatures. If the solid phases are same and the difference between T_2 and T_1 is small, the value of Δq_1 should be close to the value of Δq_2 i.e. $\Delta q_1 \approx \Delta q_2$. The dividing equations (4) and (5) gives

$$\Delta S_{f2} = \Delta S_{f1} \frac{T_1}{T_2}. \quad (6)$$

If the value of ΔS_{f1} at T_1 is known or determined for a solid phase in binary eutectic system, the value of ΔS_{f2} at T_2 can be then estimated from equation (6) by using the values of ΔS_{f1} , T_1 and T_2 for the same solid phase in ternary eutectic system. Some physical properties for solid CuAl₂ in equilibrium with (Al + 26.82 wt.% Cu + 5.27 wt.% Si) eutectic liquid given in table 5.

3. Results and discussions

3.1. Determination of Gibbs–Thomson coefficient

To determine Γ from the numerical method, the groove coordinates of the GBGSs, R and G_S must be known. The total standard uncertainty in the determination of Γ is given table 4.The GBGSs for solid CuAl₂ in equilibrium with the (Al + 26.82 wt.% Cu + 5.27 wt.% Si) eutectic liquid were observed and a typical GBGS was shown in figure 3(d). To determine Γ for solid CuAl₂ with the numerical model we have used ten equilibrated GBGSs. We have determined Γ for both sides of these ten groove shapes. The determined values of Γ for solid CuAl₂ are given in table 4. The average value of Γ from table 4 is found to be $5.59 \cdot 10^{-8} K \cdot m$.

3.2. Evaluation of σ_{SL} for solid CuAl₂ in the (Al + Cu + Si) alloy

For isotropic condition [11] σ_{SL} can be determined as

$$\Gamma = \frac{\sigma_{SL}}{\Delta S_f}. \quad (7)$$

TABLE 5Some physical properties for solid CuAl₂ in equilibrium with (Al + 26.82 wt.% Cu + 5.27 wt.% Si) (Al + 13.5 at.% Cu + 6.0 at.% Si) eutectic liquid.

Alloy	Solid phase	Liquid phase	Eutectic melting point/(K)	$\Delta S^*/(J \cdot K^{-1} \cdot m^{-3})$
(Al + Cu)	(Al + 31.94 at.% Cu)	(Al + 17.30 at.% Cu)	821 [11]	$1.59 \cdot 10^6$ [11]
(Al + Cu + Si)	CuAl ₂	(Al + 13.5 at.% Cu + 6.0 at.% Si)	795 [4]	$1.64 \cdot 10^6$ [PW]

TABLE 6

A comparison of the values of Γ , σ_{SL} and σ_{gb} for CuAl₂ obtained in the present work with the values of Γ , σ_{SL} and σ_{gb} obtained in previous works for similar eutectic alloys at pressure $p = 0.1$ MPa.^a

System	Solid phase	Liquid phase	Temperature/(K)	Entropy $\Delta S_f \cdot 10^6 / (J \cdot K \cdot m^{-3})$	$\Gamma \cdot 10^{-8} / (K \cdot m)$	$\sigma_{SL} \cdot 10^{-3} / (J \cdot m^{-2})$	$\sigma_{gb} \cdot 10^{-3} / (J \cdot m^{-2})$
(Al + Cu + Si)	CuAl ₂	(Al + 13.5 at.% Cu + 6.0 at.% Si)	795 [4]	1.6 [PW]	5.59 [PW]	91.70 [PW]	177.20 [PW]
(Al + CuAl ₂)	(Al + 32.0 at.% Cu)	(Al + 17.3 at.% Cu)	821 [11]	1.5 ± 0.08 [11]	5.50 ± 0.44 [11]	87.78 ± 11.41 [11]	173.10 ± 24.23 [11]
	(Al + 32.0 at.% Cu)	(Al + 17.3 at.% Cu)	821 [18]	1.5 ± 0.05 [18]	5.54 ± 0.39 [18]	88.36 ± 10.60 [18]	
(Al + Cu + Ag)	CuAl ₂ solution (Al + 32.31 at.% Cu + 0.04 at.% Ag)	(Al + 16.57 at.% Ag + 11.87 at.% Cu)	775.09 [22]	1.9 ± 0.10 [20]	5.10 ± 0.90 [20]	96 ± 17 [20]	172.10 ± 22.40 [21]
	CuAl ₂ solution (Al + 32.31 at.% Cu + 0.04 at.% Ag)	(CuAl ₂ + 23.6 at.% Ag ₂ Al)	799.35 [22]	1.3 ± 0.07 [21]	6.70 ± 0.50 [21]	86.90 ± 10.40 [21]	

PW: present work.

^a Standard uncertainties are $u(\Gamma) = \pm 0.045 \cdot 10^{-8} K \cdot m$, $u(\sigma_{SL}) = \pm 0.08 \cdot 10^{-3} J \cdot m^{-2}$, $u(x) = \pm 0.002$, $u(\sigma_{gb}) = \pm 0.09 \cdot 10^{-3} J \cdot m^{-2}$ and $u(p) = \pm 10$ kPa.

In order to obtain σ_{SL} from equation (7), one have to know the values of Γ and ΔS_f . σ_{SL} between solid CuAl₂ and eutectic liquid was determined to be $91.7 \cdot 10^{-3} J \cdot m^{-2}$. The total standard uncertainty of determining σ_{SL} in this study is given in table 6.

3.3. Calculation of σ_{gb} for solid CuAl₂ in the (Al + Cu + Si) alloy

If the grains are the same at the both side of the groove, σ_{gb} can be stated by

$$\sigma_{gb} = 2 \sigma_{SL} \cos \left(\frac{\theta_A + \theta_B}{2} \right), \quad (8)$$

where θ_A and θ_B are the angles of the both side of the groove shapes make with the y axis. From equation (8), $\sigma_{gb} \leq 2\sigma_{SL}$.

The value of σ_{gb} between solid CuAl₂ with the eutectic liquid was found to be $177.2 \cdot 10^{-3} J \cdot m^{-2}$ from equation (8). The total standard uncertainty in the calculation of σ_{gb} is given table 6.

The anisotropy of the interfacial energy is crucial for phase transformations. But the exact determination of this value is very difficult and there is limited number of research papers in the literature. Since the anisotropy of interfacial energy for solid CuAl₂ is unknown, the interfacial energy between solid CuAl₂ with (Al + Cu + Si) eutectic liquid was supposed to be isotropic in this study.

Values of Γ , σ_{SL} and σ_{gb} for solid CuAl₂ determined in this study were compared with the similar quantities for ternary alloys evaluated in previous works as shown in table 6. The average value of Γ obtained by Ocak *et al.* [21] is bigger than the value of Γ obtained in present and previous works. The values of σ_{SL} and σ_{gb} obtained in present and previous works are in good agreement with each other in the limits of experimental errors as shown in table 6. All experiments for measuring the thermal conductivity, Gibbs–Thomson coefficient, (solid + liquid) interfacial energy and grain boundary energy have done in atmospheric pressure in radial heat flow apparatus.

4. Conclusions

In this study, some thermophysical properties and microstructure of eutectic (Al + Cu + Si) alloy system were studied. The results obtained in this study are summarised as follows:

- Phase analysis and microstructure of eutectic (Al + Cu + Si) ternary alloy system have been examined with SEM and EDX analysis on different parts of the samples. α -Al, Si and CuAl₂ phases have been found from EDX analysis.
- Thermal conductivities of solid and liquid phases of CuAl₂ phase in (Al + Cu + Si) alloy have been obtained. Values of K_S and K_L obtained in the present work have been compared with the same values of (Al + Cu) and (Al + Cu + Ag) systems obtained in previous works [11,20,21]. Values of K_S values obtained in this study was slightly bigger but K_L values was slightly lower than those obtained in previous works.
- The GBGSs between solid CuAl₂ and the (Al + Cu + Si) eutectic liquid were viewed.
- Γ , σ_{SL} and σ_{gb} of solid CuAl₂ in equilibrium with (Al + Cu + Si) eutectic liquid have been determined. When we have compared the determined thermophysical values (Γ , σ_{SL} and σ_{gb}) in this work with related studies in literature, we have seen good agreement.

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