

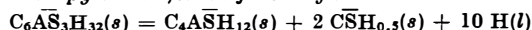
TERMINATION OF STANDARD ENTHALPIES AND
GIBBS' ENERGIES OF FORMATION FOR $6 \text{ CaO} \cdot \text{Al}_2\text{O}_3 \cdot 3 \text{ SO}_3 \cdot$
 $\text{O}(\text{C}_6\text{A}\bar{\text{S}}_3\text{H}_{32})$ AND $4 \text{ CaO} \cdot \text{Al}_2\text{O}_3 \cdot \text{SO}_3 \cdot 12 \text{ H}_2\text{O}(\text{C}_4\text{A}\bar{\text{S}}\text{H}_{12})$ BY THE
DHA*) METHOD

VLADIMÍR ŠATAVA

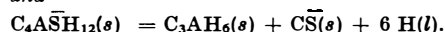
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The DHA method was used to determine the equilibrium temperatures and the reaction enthalpy values for the following reactions:



and



The data obtained were used for calculating the following values of $\text{C}_6\text{A}\bar{\text{S}}_3\text{H}_{32}$,

$$\Delta H_f^\circ (298 \text{ K}) = -17\,492.5 \text{ kJ mole}^{-1}, \quad S^\circ (298 \text{ K}) = 1\,891.6 \text{ J mole}^{-1} \text{ K}^{-1}$$

and

$$\Delta G_f^\circ (298 \text{ K}) = -15\,156.2 \text{ kJ mole}^{-1},$$

and the following values for $\text{C}_4\text{A}\bar{\text{S}}\text{H}_{12}$:

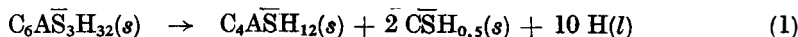
$$\Delta H_f^\circ (298 \text{ K}) = -8\,716.9 \text{ kJ mole}^{-1}, \quad S^\circ (298 \text{ K}) = 791.0 \text{ J mole}^{-1} \text{ K}^{-1}$$

and

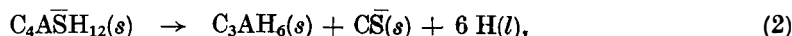
$$\Delta G_f^\circ (298 \text{ K}) = -7\,732.1 \text{ kJ mole}^{-1}.$$

INTRODUCTION

In the system $\text{C—A—}\bar{\text{S}}\text{—H}$ there exist two hydrated sulphoaluminates, $\text{C}_6\text{A}\bar{\text{S}}_3\text{H}_{32}$ (ettringite) and $\text{C}_4\text{A}\bar{\text{S}}\text{H}_{12}$ (the low-sulphate form) [1, 2, 3]. Babushkin, Matveyev and Mchedlov-Petrosyan [4] calculated the thermodynamic data of the two phases using the method of structural analogy. However, direct experimental data are still lacking for exact predictions of the phase and chemical equilibria participated in by these substances. An opportunity for their determination is provided by the reactions



and



which establish equilibria quite readily under hydrothermal conditions, and the DHA method [5, 6] allows both the equilibrium temperatures and the corresponding reaction enthalpies to be determined.

*) DHA = Differential Hydrothermal Analysis

EXPERIMENTAL

Materials

$C_6\bar{A}\bar{S}_3H_{32}$ was synthesized by the reaction of C_3A with $\bar{C}\bar{S}H_2$, both of A.R. purity, mixed at a 1 : 3 molar ratio in CO_2 -free water. The suspension was mixed for two days at 25 °C, the solid phase separated by filtering through G3 glass filter in N_2 atmosphere and kept in the form of paste containing approx. 30 % H_2O . The purpose was to avoid dehydration of ettringite by drying, which could lead to errors in the determination of the sample composition. $C_4\bar{A}\bar{S}H_{12}$ was prepared by the method described by Kuzel [7]. The chemical and TG analyses of both samples corresponded satisfactorily to the composition required. X-ray analysis and scanning electron micrographs revealed no foreign phases.

Method

Use was made of the apparatus for DHA described in earlier works [5, 6]. Powdered graphite, which is a non-reactive material in the given medium, was used as standard sample. The autoclave was filled with CO_2 -free water so as to provide free space for the vapour phase. The pressure in the autoclave was then defined as the pressure of saturated water vapour at the given temperature.

The heating rate 10 °C/min was controlled automatically (regulator by Netsch, FRG) and the time course of the temperature increase recorded by a line recorder together with the DTA curve.

The reaction enthalpies were determined planimetrically using an inner standard. Powdered In of A.R. purity, whose melting at 156 °C is indicated by a peak occurring without overlapping just behind the peak of reaction (1), was employed for reaction (1). Similarly, powdered Sn was used as an inner standard for reaction (2), its melting temperature is 232 °C and the corresponding peak appears on the DHA curve immediately at the foot of the peak corresponding to reaction (2). The enthalpy of fusion for In and Sn respectively, $\Delta H_{fus}^\circ = 3.265 \text{ J mole}^{-1}$ and $6.992 \text{ J mole}^{-1}$, were taken over from Tables [9].

The weighed specimen in paste form was mixed with the weighed amount of powdered inner standard and introduced into the specimen holder in the DHA apparatus. The proportion of the effective component in the paste was calculated from the content of the anhydrous component determined by the TG method and expressed as $C_6\bar{A}\bar{S}_3H_{32}$ and $C_4\bar{A}\bar{S}H_{12}$ respectively.

The measuring method described was verified by determining the reaction enthalpy of the reaction



which can be readily effected under the DHA conditions. The maximum error of the individual measurement amounted to 5 %.

RESULTS AND DISCUSSION

Determination of the equilibrium temperatures of reactions (1) and (2)

At a heating rate of $10 \text{ }^\circ\text{C min}^{-1}$, reaction (1) is indicated on the DHA curve by an endothermic peak in the temperature range of 115 to 135 °C. By determining the dependence of the peak onset temperature on the heating rate and by extrapolating

this dependence to a zero heating rate, the equilibrium temperature of reaction (1) was established, $T_{r(1)} = (384 \pm 1)$ K [6]. The equilibrium temperature of reaction (2), $T_{r(2)} = (450 \pm 2)$ K was found in the same way. The temperatures obtained were then checked by verifying the long-term stability of $C_6\bar{A}\bar{S}_3H_{32}$ below the temperature of 384 K, and that of $C_4\bar{A}\bar{S}H_{12}$ below 450 K. Ettringite in equilibrium with aqueous solution (a dense suspension) was heated in the DHA apparatus up to 382 ± 1 K and kept at this temperature for 8 hours. The DTA curve was then recorded at a heating rate of $10^\circ\text{C min}^{-1}$. The ettringite peak on the DTA curve remained unchanged, i.e. the phase composition was not affected by the 8-hour heating. The same procedure was used in the case of $C_4\bar{A}\bar{S}H_{12}$.

Determination of reaction enthalpies

The planimetric measurement of the peaks [8] was well reproducible, as the zero line of the DHA curves did not deviate from the horizontal temperature axis.

The mean values of reaction enthalpy were then determined from 10 repeated analyses:

$$\Delta H_{r(1)}(384\text{ K}) = (188.41 \pm 4.19) \text{ kJ mole}^{-1}$$

and

$$\Delta H_{r(2)}(450\text{ K}) = (50.66 \pm 4.19) \text{ kJ mole}^{-1}.$$

In this we neglected the fact that

1. the reactions proceed over a certain temperature interval and not at the equilibrium temperature,

2. the reactions do not proceed under the standard pressure ($P^\circ = 0.101$ MPa). Since, however, the reactions take place in condensed phase and the pressure does not exceed 2 MPa, the effect of pressure on the activity of the reacting components can be neglected.

The dependence of ΔC_p on temperature was neglected in converting the $\Delta H_{r(1)}$ values to the temperature of 298 K, and the standard enthalpies of combination for both sulphoaluminates were calculated by means of the tabellated values of standard enthalpies of formation [4] of the other substances involved.

For reaction (2) one obtains the value

$$\begin{aligned} \Delta H_f^\circ(C_4\bar{A}\bar{S}H_{12}) &= \Delta H_f^\circ(C_3\bar{A}H_6) + \Delta H_f^\circ(\bar{C}\bar{S}) + 6 \Delta H_f^\circ(H) - \Delta H_{r(2)} = \\ &= (-5,516.53 - 1,433.56 - 1,716.17 - 50.66) \text{ kJ mole}^{-1} = \\ &= -8,716.9 \text{ kJ mole}^{-1}, \end{aligned} \quad (3)$$

which is in a satisfactory agreement with that given by Babushkin et al. [4].

If the temperature dependence of molar thermal capacities according to Babushkin [4] were employed in the conversion of the $\Delta H_{r(2)}(450\text{ K})$ to $\Delta H_{r(2)}(298\text{ K})$ one would obtain the value

$$\Delta H_f(C_4\bar{A}\bar{S}H_{12}) = -8,714.8 \text{ kJ mole}^{-1},$$

which is likewise in a good agreement with the value found by Babushkin.

Similarly, it follows from the enthalpic balance of reaction (1) on the assumption that $\Delta C_p = 0$, that

$$\begin{aligned} \Delta H_f^\circ(C_6\bar{A}\bar{S}_3H_{32}) &= \Delta H_f^\circ(C_4\bar{A}\bar{S}H_{12}) + 2 \Delta H_f^\circ(\bar{C}\bar{S}H_{0.5}) + 19 \Delta H_f^\circ(H) - \Delta H_{r(1)} = \\ &= (-8,716.92 - 3,152.41 - 5,434.80 - 188.41) \text{ kJ mole}^{-1} = \\ &= -17,492.5 \text{ kJ mole}^{-1}. \end{aligned} \quad (4)$$

The value of ΔH_f° tabellated by Babushkin holds for ettringite containing 31 water molecules in the formula of the substance. On the assumption that the contribution of the weakly bound water molecule in the zeolitic structure of ettringite is equal to $\Delta H_f^\circ(\text{H}_2\text{O}(l)) = -286.04 \text{ kJ mole}^{-1}$, one would obtain $\Delta H_f^\circ(\text{C}_6\text{AS}_3\text{H}_{32}) = -17,497.97 \text{ kJ mole}^{-1}$, which agrees well with the value determined in our direct measurements.

The somewhat higher value of $\Delta H_f^\circ(\text{C}_6\text{AS}_3\text{H}_{32}) = -17,555.25 \text{ kJ mole}^{-1}$ was obtained by Berman and Newmann [10] from the measurements of heats of dissolution.

From the values of $\Delta H_{r(1)}$ and $\Delta H_{r(2)}$ established and from the corresponding equilibrium temperatures it follows that

$$\Delta S_{r(2)} = \frac{\Delta H_{r(2)}(450 \text{ K})}{T_{r(2)}} = 112.58 \text{ J K}^{-1} \text{ mole}^{-1} \quad (5)$$

and

$$\Delta S_{r(1)} = \frac{\Delta H_{r(1)}(384 \text{ K})}{T_{r(1)}} = 490.65 \text{ J K}^{-1} \text{ mole}^{-1}. \quad (6)$$

On assuming that $\Delta C_p = 0$, the entropy balance for equation (2) yields the value ($T = 298 \text{ K}$)

$$\begin{aligned} S^\circ(\text{C}_4\text{AS}_3\text{H}_{12}) &= S^\circ(\text{C}_3\text{AH}_6) + S^\circ(\text{CS}) + 6 S^\circ(\text{H}) - \Delta S_{r(2)} = \\ &= (376.81 + 106.76 + 420.02 - 112.58) \text{ J K}^{-1} \text{ mole}^{-1} = \\ &= 791.01 \text{ J K}^{-1} \text{ mole}^{-1}, \end{aligned} \quad (7)$$

and the balance for equation (1) the value ($T = 298 \text{ K}$)

$$\begin{aligned} S^\circ(\text{C}_6\text{AS}_3\text{H}_{32}) &= S^\circ(\text{C}_4\text{AS}_3\text{H}_{12}) + 2 S^\circ(\text{CSH}_{0.5}) + 19 S^\circ(\text{H}) - \Delta S_{r(1)} = \\ &= (791.01 + 261.26 + 1,330.06 - 490.65) \text{ J K}^{-1} \text{ mole}^{-1} = \\ &= 1,891.68 \text{ J K}^{-1} \text{ mole}^{-1}, \end{aligned} \quad (8)$$

where the values of the standard absolute entropies were taken from the Tables [4].

From the values obtained it follows that

$$\Delta G_{r(2)}(298 \text{ K}) = (50.66 - 298 \cdot 0.11258) \text{ kJ mole}^{-1} = 17.11 \text{ kJ mole}^{-1}$$

and for $T = 298 \text{ K}$,

$$\begin{aligned} \Delta G_f^\circ(\text{C}_4\text{AS}_3\text{H}_{12}) &= \Delta G_f^\circ(\text{C}_3\text{AH}_6) + \Delta G_f^\circ(\text{CS}) + 6 \Delta G_f^\circ(\text{H}) - \Delta G_{r(2)} = \\ &= (-4,969.73 - 1,321.19 - 1,424.10 - 17.11) \text{ kJ mole}^{-1} = \\ &= -7,732.13 \text{ kJ mole}^{-1}. \end{aligned} \quad (9)$$

This value is likewise in a comparatively good agreement with the value given by Babushkin, i.e. $\Delta G_f^\circ(\text{C}_4\text{AS}_3\text{H}_{12}) = -7,718.78 \text{ kJ mole}^{-1}$.

Similarly,

$$\Delta G_{r(1)}(298 \text{ K}) = (188.41 - 298 \cdot 0.49065) \text{ kJ mole}^{-1} = 42.20 \text{ kJ mole}^{-1}$$

and for $T = 298 \text{ K}$,

$$\begin{aligned} \Delta G_f^\circ(\text{C}_6\text{AS}_3\text{H}_{32}) &= \Delta G_f^\circ(\text{C}_4\text{AS}_3\text{H}_{12}) + 2 \Delta G_f^\circ(\text{CSH}_{0.5}) + 19 \Delta G_f^\circ(\text{H}) - \Delta G_{r(1)} = \\ &= (-7,732.13 - 2,872.31 - 4,509.64 - 42.20) \text{ kJ mole}^{-1} = \\ &= -15,156.28 \text{ kJ mole}^{-1}. \end{aligned} \quad (10)$$

The value of ΔG_f° for ettringite obtained by Babushkin and calculated for a content of 32 water molecules in the formula molecule of ettringite would be

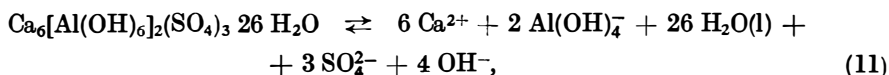
$$\Delta G_f^\circ(\text{C}_6\text{AS}_3\text{H}_{32}, 298 \text{ K}) = -15,127.08 \text{ kJ mole}^{-1}.$$

The difference of about 29 kJ from the value obtained from our measurement is larger than the experimental error, and the correct value should be decided on by experiment.

It is first of all the equilibrium of reaction (1) for which we determined experimentally the temperature of 111 °C. According to Babushkin, the temperature is 74 °C, which is in disagreement with direct measurement.

The fact that the equilibrium of reaction (1) lies at a temperature higher than 74 °C is implied by Lieber's measurements [11], who proved that ettringite was stable with its aqueous solution at 90 °C. Ogawa [12] specifies an equilibrium temperature of reaction [1] even at 130 °C. However, the equilibrium temperature of reaction [1] cannot be higher than the temperature of the peak onset on the DHA curve, which even at a heating rate of 10 °C min⁻¹ amounts to 115 °C.

The solubility product of ettringite can be employed as the second criterion for assessing the correctness of the data. For the upper limit of the solubility product for ettringite, corresponding to the equilibrium of the reaction



one obtains

$$K_E = a^6(\text{Ca}^{2+}) \cdot a^2(\text{Al}(\text{OH})_4^-) \cdot a^3(\text{SO}_4^{2-}) \cdot a^4(\text{OH}^-). \quad (11a)$$

Using the experimental data by Jones [1] and the corrections given from the activity coefficients [13] one obtains the value

$$K_E \leq 10^{-36}.$$

The corresponding $\Delta G_{r(11)}$ will then be

$$\Delta G_{r(11)} = -RT \ln K_E = (-19.1588 \cdot 298 \cdot (-36)) \text{ J mole}^{-1} = 205.536 \text{ kJ mole}^{-1}.$$

However, since

$$\Delta G_{r(11)}^\circ = 6 \Delta G_f^\circ(\text{Ca}^{2+}) + 2 \Delta G_f^\circ(\text{Al}(\text{OH})_4^-) + 3 \Delta G_f^\circ(\text{SO}_4^{2-}) + 4 \Delta G_f^\circ(\text{OH}^-) + 26 \Delta G_f^\circ(\text{H}_2\text{O}(\text{l})) - \Delta G_f^\circ(\text{C}_6\text{AS}_3\text{H}_{32}), \quad (12)$$

on substituting the tabellated values of standard Gibbs's energies of formation of the substances involved [14],

$$\Delta G_f^\circ(\text{C}_6\text{AS}_3\text{H}_{32}) = -15,168 \text{ kJ mole}^{-1}.$$

The value obtained in our measurements, $\Delta G_f^\circ = -15,156.28 \text{ kJ mole}^{-1}$, is obviously in a better agreement with the value calculated from the solubility product, than the value $\Delta G_f^\circ = -15,127.08 \text{ kJ mole}^{-1}$, which was established by Babushkin's semiempirical calculation*).

*) The value of $\Delta G_f^\circ(\text{C}_6\text{AS}_3\text{H}_{32})$ established by the present authors would indicate the solubility product value $K_E = 1.09 \times 10^{-34}$.

As the third criterion, let us use the reaction according to the equation



for whose equilibrium (metastable) our data allow the temperature $T_0 = 378.6\text{ K}$, i.e. 105.5°C to be predicted. As it is possible to overheat gypsum readily in aqueous suspension up to 118°C [15], the DHA curve of a mixture of ettringite with very fine gypsum (mixed in an approximate weight ratio of 1 : 1) exhibits a peak corresponding to reaction (13) and the temperature of its onset, extrapolated linearly to zero heating rate, actually corresponds to the predicted temperature of 105°C . The ratio of the reaction enthalpies for reactions (1) and (2) is

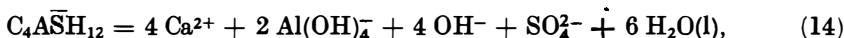
$$\frac{\Delta H_{\text{r}(1)}}{\Delta H_{\text{r}(2)}} = 3.72.$$

The reaction enthalpy of reaction (13) will then be

$$\begin{aligned} \Delta H_{\text{r}(13)} &= \Delta H_{\text{f}}^\circ(\text{C}_4\text{A}\bar{\text{S}}\text{H}_{12}) + 2\Delta H_{\text{f}}^\circ(\text{C}\bar{\text{S}}\text{H}_2) + 16\Delta H_{\text{f}}^\circ(\text{H}) - \Delta H_{\text{f}}^\circ(\text{C}_6\text{A}\bar{\text{S}}_3\text{H}_{32}) = \\ &= (-8,716.92 - 4,044.95 - 4,576.47 + 17,492.5)\text{ kJ mole}^{-1} = 154.16\text{ kJ mole}^{-1}, \end{aligned}$$

and the ratio of the enthalpies, $\frac{\Delta H_{\text{r}(13)}}{\Delta H_{\text{r}(2)}} = 3.04$.

The value determined by measuring the peak areas agreed well with these data. Similarly for $\text{C}_4\text{A}\bar{\text{S}}\text{H}_{12}$, on the basis of the reaction



the following is obtained from the tabellated values of $\Delta G_{\text{f}}^\circ(i)$ and the value of $\Delta G_{\text{r}}^\circ(\text{C}_4\text{A}\bar{\text{S}}\text{H}_{12})$ obtained by our measurements:

$$\Delta G_{\text{r}}^\circ(14) = 131.675\text{ kJ mole}^{-1}, \text{ of which } K_{\text{s}} = 8.65 \times 10^{-24}.$$

The only value of the solubility product of $\text{C}_4\text{A}\bar{\text{S}}\text{H}_{12}$ was measured directly by Zhang and Zhou [16], $K_{\text{s}} = 1.7 \times 10^{-28}$. This value is lower by 4 orders of magnitude than the value found by the present author, but the values of K_{s} established by the above authors for other compounds, are likewise smaller than those measured by other workers. For example, for $\text{C}_4\text{A}\text{Cl}_2\text{H}_{11}$ they found $K_{\text{s}} = 1 \times 10^{-30}$, whereas Goto [17] found $K_{\text{s}} = 3.78 \times 10^{-28}$. The K_{s} value of ettringite is even 1×10^{-40} , which is lower by four orders of magnitude, than the value determined by Hampson and Bailey [13].

CONCLUSION

The DHA method was used in determining the thermodynamic data ($\Delta H_{\text{f}}^\circ$, S° and $\Delta G_{\text{f}}^\circ$) of hydrated calcium sulphoaluminates $\text{C}_6\text{A}\bar{\text{S}}_3\text{H}_{32}$ and $\text{C}_4\text{A}\bar{\text{S}}\text{H}_{12}$ for 298 K . The data established were confronted with other experimental data on the behaviour of these phases.

References

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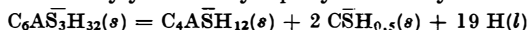
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STANOVENÍ STANDARDNÍCH SLUČOVACÍCH ENTALPIÍ
A SLUČOVACÍCH GIBBSOVÝCH ENERGÍÍ $6 \text{ CaO} \cdot \text{Al}_2\text{O}_3 \cdot 3 \text{ SO}_3 \cdot 32 \text{ H}_2\text{O}$
($\text{C}_6\text{A}\bar{\text{S}}_3\text{H}_{32}$) A $4 \text{ CaO} \cdot \text{Al}_2\text{O}_3 \cdot \text{SO}_3 \cdot 12 \text{ H}_2\text{O}$ ($\text{C}_4\text{A}\bar{\text{S}}\text{H}_{12}$) METODOU DHA

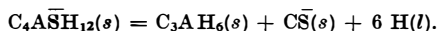
Vladimír Šatava

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Metodou DHA byly stanoveny teploty rovnováhy a hodnoty reakční entalpie reakcí



a



Ze získaných dat se vypočetly pro $\text{C}_6\text{A}\bar{\text{S}}_3\text{H}_{32}$ hodnoty

$$\Delta H_f^\circ(298 \text{ K}) = -17\,492,5 \text{ kJ} \cdot \text{mol}^{-1}, S^\circ(298 \text{ K}) = 1\,891,68 \text{ J} \cdot \text{mol}^{-1} \cdot \text{K}^{-1}$$

a

$$\Delta G_f^\circ(298 \text{ K}) = -15\,156,28 \text{ kJ} \cdot \text{mol}^{-1},$$

a pro $\text{C}_4\text{A}\bar{\text{S}}\text{H}_{12}$ hodnoty

$$\Delta H_f^\circ(298 \text{ K}) = -8\,716,9 \text{ kJ} \cdot \text{mol}^{-1}, S^\circ(298 \text{ K}) = 791,01 \text{ J} \cdot \text{mol}^{-1} \cdot \text{K}^{-1}$$

a

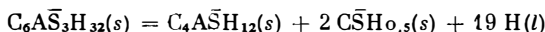
$$\Delta G_f^\circ(298 \text{ K}) = -7\,732,13 \text{ kJ} \cdot \text{mol}^{-1}.$$

ОПРЕДЕЛЕНИЕ СТАНДАРДНОЙ ЭНТАЛЬПИИ
ОБРАЗОВАНИЯ И ЭНЕРГИЙ ОБРАЗОВАНИЯ ГИББСА
 $66 \text{ CaO} \cdot \text{Al}_2\text{O}_3 \cdot 3 \text{ SO}_3 \cdot 32 \text{ H}_2\text{O}$ ($\text{C}_6\text{A}\bar{\text{S}}_3\text{H}_{32}$) И $4 \text{ CaO} \cdot \text{Al}_2\text{O}_3 \cdot \text{SO}_3 \cdot 12 \text{ H}_2\text{O}$ ($\text{C}_4\text{A}\bar{\text{S}}\text{H}_{12}$)
МЕТОДОМ ДНА

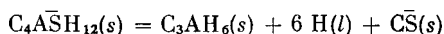
Владимир Шатава

кафедра технологии силикатов, Химико-технологический институт, 166 28 Прага

С помощью метода ДНА устанавливали температуры равновесного состояния и величины энтальпии образования согласно отношениям



и



Из полученных данных рассчитали для $C_6AS_3H_{32}$ величины

$$\Delta H_f^\circ (298\text{ K}) = -17\,492,5 \text{ кДж} \cdot \text{мол}^{-1}, \quad S^\circ (298\text{ K}) = 1\,891,68 \text{ Дж} \cdot \text{мол}^{-1} \cdot \text{K}^{-1}$$

и

$$\Delta G_f^\circ (298\text{ K}) = -15\,156,28 \text{ кДж} \cdot \text{мол}^{-1},$$

и для C_4ASH_{12} величины

$$\Delta H_f^\circ (298\text{ K}) = -8\,716,9 \text{ кДж} \cdot \text{мол}^{-1}, \quad S^\circ (298\text{ K}) = 791,01 \text{ Дж} \cdot \text{мол}^{-1} \cdot \text{K}^{-1}$$

и

$$\Delta G_f^\circ (298\text{ K}) = -7\,732,13 \text{ кДж} \cdot \text{мол}^{-1}.$$

FORMING OF CERAMICS (Tvarování keramiky). Proceedings of a special conference of the 85th Annual Meeting of the American Ceramic Society, held on April 24—27, 1983, in Chicago, Illinois (Sborník z konference uspořádané při 85. výročním zasedání Americké keramické společnosti 24.—27. 4. 1983 v Chicagu, Illinois). Edited by J. A. Mangels and G. L. Messing. Advances in Ceramics, Vol. 9. The American Ceramic Society, Inc., Columbus, Ohio, 1984. 287 str.

Moderní technická keramika musí splňovat náročné požadavky na vlastnosti a jejich reprodukovatelnost, a tím i na spolehlivost konečných součástí. Výsledek je do značné míry závislý i na tvarovacích operacích. Proto uspořádala Americká keramická společnost v r. 1983 konferenci na toto téma. Jednání se soustředilo na pět základních tvarovacích postupů, z nichž tři lze pokládat za tradiční (lisování, lití, tažení) a dva za nové (lití tenkých vrstev a vstřikování). Sborník přináší celkem 29 referátů s následujícími tituly:

Výběr materiálů pro lisovací nástroje (T. H. Magdic). Izostatické lisování v suché formě a obrysové broušené technické keramiky (D. B. Quinn et al.). Konstrukce nástrojů pro izostatické lisování v mokré formě (B. J. McEntire). Zdokonalená výroby trubíc z Al_2O_3 pro sodíkové výbojky (G. A. Fryburg, F. B. Makar). Vliv vlhkosti na lisovací vlastnosti Al_2O_3 sušeného rozprašováním (R. A. DiMilia, J. S. Reed). Tři indexy pro charakterizaci tabletovacích schopností materiálů (E. N. Hiestand, D. P. Smith). Tvrdost a plastičnost pojiva při lisování granulí (C. W. Nies, G. L. Messing). Úloha práškových aglomerátů při keramickém zpracování (J. W. Halloran). Tvarování litím a odlévání (J. E. Funk). Mechanika koloidní filtrace (I. A. Aksay, C. H. Schilling). Řízení mikrostruktury koloidní filtrace (I. A. Aksay). Lití koloidního monodispersního SiO_2 (M. Velasquez, S. C. Danforth). Výroba elektromechanických měničů litím tenkých vrstev (G. O. Dayton et al.). Lití tenkých vrstev — budoucí vývoj (E. S. Tormey et al.). Vlivy rozdělení velikosti částic na lití fólií z titančitanu barnatého (R. J. McKinnon, J. B. Blum). Ultrazvuková dispergace suspenzí pro lití fólií z $BaTiO_3$ (R. J. McKinnon, J. B. Blum). Dispergační činidla pro lití fólií z čistého titančitanu barnatého (K. Mikeska, W. R. Cannon). Tažení hmot pro elektrotechnický porcelán (J. E. Funk). Parametry keramické hmoty ovlivňující tažení (G. A. Ackley, J. S. Reed). Porovitost v celulární keramice vyrobené tažením (I. M. Lachman). Žárové tažení keramiky (B. C. Mutsuddy). Keramické součástky vyráběné vstřikovacím tvarováním (J. A. Mangels, W. Trela). Zařízení pro vstřikovací tvarování keramických těles (J. R. Peshek). Nástroje pro keramické vstřikovací tvarování (V. V. Stanciu). Řízená tepelná extrakce organických pojiv z těles tvarovaných vstřikováním (A. Johnsson et al.). Metoda k určení kritické objemové koncentrace keramického prášku při plasticím tvarování keramických směsí (C. J. Markhoff et al.). Praktický přístup ke srovnávání viskozity měřené metodou kapilární a metodou spirálového toku pro tvarování keramických směsí (B. C. Mutsuddy, L. R. Kahn). Počítačové modelování toku tekutin (R. Holman et al.). Vakuové vstřikovací tvarování sklometalických elektrických součástek (D. P. Kramer, R. T. Massey).

Jak vyplývá z přehledu názvů referátů, je náplň knihy značně různorodá a zahrnuje jak práce vědecké, tak i s rýze praktickou orientací. Jejich obsahem jsou procesy, zařízení, materiály a různé techniky. Hlavní zaměření je na moderní technickou keramiku.

Knihla je určena inženýrům a výzkumným pracovníkům, kteří se zabývají tvarováním keramiky, ale také těm, jejichž oborem je aplikace nových typů materiálů v technice.

Hlaváč