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STATISTICAL VERIFICATION OF ATTRIBUTION VISCOSITY VALUES TO THE CORRESPONDING SIGNIFICANT POINTS ON THE DTA CURVES OF GLASSES IN THE $CaO - MgO - Al_2O_3 - SiO_2 - B_2O_3$ SYSTEM (CMASB)

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ABSTRACT

In this work possibility of attribution viscosity values to some points on DTA curves was investigated using statistical methods. In the case of 41 glasses in the system CMASB, this proved to be impossible. It means that temperatures of characteristic points on DTA curves and temperatures of viscosity points are practically independent. Obtained results are in disagreement with those published in the work[1].

INTRODUCTION

Some authors[1,2] pointed out possibility to attribute constant viscosity values to some important points on DTA curves of glasses. As such a possibility would have not only theoretical but a great practical importance as well we decided to test the attribution statistically for glasses having compositions close to the commercial glass EUTAL.

MEASURING METHODS

The DTA curves were measured[4] by DTA analyser NETZSCH 404. Viscosity was measured by rotating viscosimeter Rheotest II (GDR), which had been arranged for the aperiodic method of mesuring melt viscosity[3]. Measurements of viscosity were carried out in the range of $10^2 - 10^9$ dPa.s.

RESULTS AND DISCUSSION

Experimental base was represented by 41 glass samples having their compositions derived from the composition of the commercial glass EUTAL altering concentrations of all the oxides up to $\pm$ 4 mass %. Compositions of the glasses are presented in the work[4]. Four important points were observed on DTA curves of the glasses. Two of them (B_c - beginning of crystallization and T_{soft} - Littletons' softening point) are in the interval where direct measurements of viscosity curves were carried out. Viscosity curves for all glasses were described by Fulchers' equation[5] and viscosity

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values $\eta_{i,j}^{DTA}$ were attributed to the important points of the DTA curves (tab.1):

$$\log \eta_{i,j}^{DTA} = A_j + \frac{B_j}{T_{i,j}^{DTA} - T_{0,j}} , \quad \begin{array}{l} i=B_c,\ soft \\ j=1,2...41 \end{array}$$

where $T_{i,j}^{DTA}$ is the temperature of the significant point i for the sample j; A_j, B_j and $T_{0,j}$ are constants of Fulchers' equation for the j-th sample.

Supposing that definit (constant) viscosity values can be attributed to the individual characteristic points of a DTA curve values $\eta_{soft,j}^{DTA}$, resp. $\eta_{B_c,j}^{DTA}$ have to be equal for all the samples, or better, they have to be symetrically dispersed round the average value $\bar{\eta}_{soft}^{DTA}$, resp. $\bar{\eta}_{B_c}^{DTA}$. The real distributions are illustrated by histograms on the fig. 1 and 2. Statistical characteristics of the distributions are summarized in tab.2. As follows from the histograms, skewness and kurtosis values, constant viscosity values can not be attributed to the individual characteristic points of a DTA curve.

Next the temperatures T_{soft}^{vis} and $T_{B_c}^{vis}$ belonging to the average viscosity values $\bar{\eta}_{soft}^{DTA}$ and $\bar{\eta}_{B_c}^{DTA}$ were calculated for all the samples (tab.1). Investigating regression relations T_{soft}^{vis} vs. T_{soft}^{DTA} , resp. T_{B}^{vis} vs. T_{B}^{DTA} only slight dependance proved to exist and its regression soefficient significantly differs from 1, that is theiretically expected. Results of regression analysis are presented in tab.3.

Obtained results can be explained so that the DTA scanning is influenced not only by viscosity but by other physical properties (as density, surface tension and so on) of measured glasses as well.

Tab.2: The distribution of $\eta_{i,j}^{DTA}$

	$\log \eta_{B_c,j}^{DTA}$	$\log \eta_{soft}^{DTA}$
Mean	8.50	7.00
Std.dev.	0.84	0.76
Skewness	-1.77	-1.34
Kurtosis	7.30	4.53

Tab.3: The linear regression $T_i^{vis} = A + B.T_i^{DTA}$

	i=soft	$i=B_c$
A	853.3 °C	742.6 °C
B	0.034	0.105
corr. coeff.	0.021	0.067

Tab.1:

Sample	T^{vis}_{soft} [°C]	T^{DTA}_{soft} [°C]	$\log \eta^{DTA}_{soft}$ [dPa.s]	T^{vis}_{Bc} [°C]	T^{DTA}_{Bc} [°C]	$\log \eta^{DTA}_{Bc}$ [dPa.s]
1	890	872	7.44	836	826	8.82
2	838	848	6.74	787	803	7.98
3	874	846	7.75	822	798	9.38
4	913	869	8.19	854	817	10.13
5	920	894	7.59	859	840	9.09
6	883	859	7.61	829	810	9.16
7	892	872	7.52	839	820	9.19
8	889	931	6.10	835	830	8.67
9	878	958	5.52	820	926	6.05
10	849	971	4.82	794	934	5.36
11	872	918	5.97	822	873	6.97
12	914	906	7.18	855	852	8.59
13	924	901	7.55	867	851	9.00
14	912	891	7.45	848	848	8.51
15	894	881	7.29	835	822	8.88
16	875	878	6.93	823	816	8.74
17	864	982	4.72	815	845	7.53
18	867	901	6.28	811	825	8.07
19	882	860	7.57	829	826	8.59
20	880	867	7.33	826	814	8.92
21	896	881	7.40	846	825	9.29
22	878	876	7.05	822	822	8.51
23	881	866	7.35	824	813	8.86
24	878	869	7.21	822	823	8.48
25	890	866	7.65	840	828	8.95
26	873	913	6.24	812	828	8.05
27	886	874	7.29	834	819	9.03
28	881	877	7.10	829	830	8.47
29	892	879	7.34	841	828	8.94
30	899	892	7.13	834	844	8.23
31	899	870	7.70	844	825	9.10
32	867	859	7.19	814	807	8.75
33	850	897	5.95	800	817	7.94
34	859	846	7.35	810	794	9.14
35	860	865	6.89	805	811	8.31
36	884	842	7.95	821	815	8.67
37	895	906	6.78	828	845	8.08
38	851	858	6.83	801	800	8.55
39	859	864	6.88	808	808	8.49
40	883	877	7.14	825	829	8.37
41	902	901	7.01	836	835	8.52

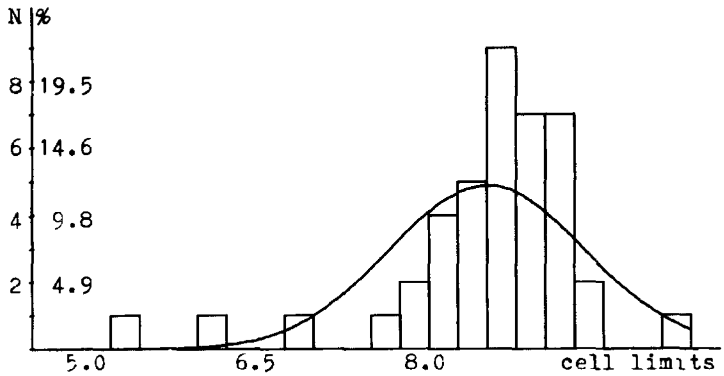

Fig.1: Distribution of log $\tau^{DTA}_{B_c,J}$ values

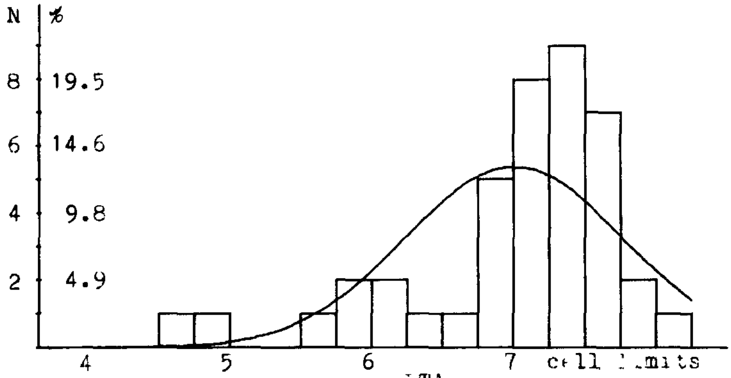

Fig.2 Distribution of log $\tau^{DTA}_{soft,J}$ values

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