THE STRUCTURE AND PROPERTIES OF GLASSES CONTAINING BORON

Sir:

In a series of papers to be published in the *Journal of the Optical Society of America*, a large amount of evidence is presented to show that the volume, the refraction, and the dispersion of that amount of a silicate glass which contains one gram atom of oxygen are simple additive functions of the ratios (N_M) of the numbers of atoms of the "metallic" elements to the number of atoms of oxygen, in accordance with the equations

$$V_0 = k + b_{Si} + c_{Si} N_{Si} + \Sigma' c_M N_M$$
$$(n\lambda - 1)V_0 = R_{0,\lambda} = \Sigma a_{M,\lambda} N_M$$
$$(n_{\lambda_1} - n_{\lambda_2})V_0 = D_{0,\lambda_1\lambda_2} = \Sigma(a_{M,\lambda_1} - a_{M,\lambda_2})N_M$$

In general, the a_M and c_M constants do not vary with the composition. The constants b_{Si} and c_{Si}, however, are different for different ranges of N_{Si}. The constant k is small, or zero, and seems to depend on the laboratory in which the data originate, presumably on the annealing technique.
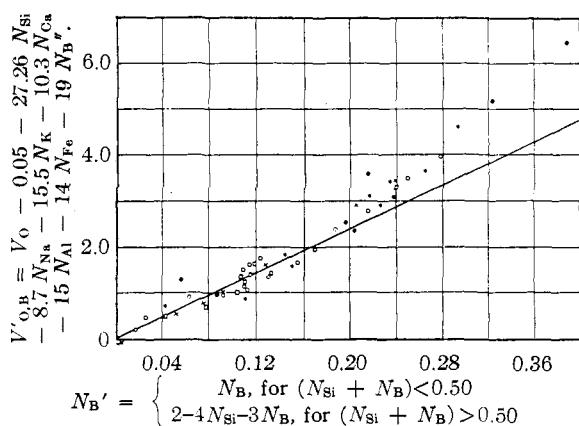

$$N_B' = \begin{cases} N_B, & \text{for } (N_{Si} + N_B) < 0.50 \\ 2-4N_{Si}-3N_B, & \text{for } (N_{Si} + N_B) > 0.50 \end{cases}$$

Fig. 1.—Data by Turner and co-workers, $(N_{Si} + N_B) >$ 0.435: O, $Na_2O-B_2O_3$; ●, $Na_2O-B_2O_3-SiO_2$; □, $Na_2O-B_2O_3-SiO_2(-CaO-Al_2O_3-Fe_2O_3)$; ×, $Na_2O-K_2O-CaO-B_2O_3-SiO_2(-Al_2O_3-Fe_2O_3)$.

Boron-containing glasses do not obey these simple equations without modification. The contribution of the boron to the volume (or the refraction or the dispersion) depends not only on N_B but also on N_{Si}. From our present knowledge of atomic and ionic radii and of the crystal structures of boron-containing compounds, we should expect that in glasses in which both N_{Si} and N_B are small (*i. e.*, in which oxygen atoms are present in relatively large proportions), most or all of the boron atoms would be surrounded tetrahedrally by four oxygen atoms. On the other hand, with large N_{Si} and N_B we should expect some of the boron atoms to be surrounded by but 3 close oxygen neighbors.

A computation of the relative amounts of B' (with 4 oxygen neighbors) and B" (with 3) is possible on the basis of the following assumptions. (1) If $(N_{Si} + N_B)$ is less than one-half, every boron atom is surrounded by 4 oxygens; (2) if $(N_{Si} + N_B)$ is greater than one-half, every oxygen atom has two silicon or boron neighbors. Assuming also (3) that the values of b_{Si} and c_{Si} depend on the range of $(N_{Si} + N_B)$, rather than on N_{Si} alone, $c_{B'}$, $c_{B''}$, $a_{B'}$ and $a_{B''}$ values have been deduced which give fair agreement with experiment, much better than is obtained on the assumption that the boron atoms are all alike, as regards their effect on the volume and refraction of glasses.

There is some indication that the actual number of B' atoms is somewhat greater than that calculated, especially for $(N_{Si} + N_B)$ near 0.50, with N_B large compared with N_{Si}. This would account for the large deviations from the straight line of the points on the right-hand side of the accompanying figure. The discrepancy might be expected to be less, the better the annealing.

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THE APPARENT MOLECULAR SHAPE AND MOLECULAR WEIGHT OF PROTEINS, FROM VISCOSITY AND DIFFUSION MEASUREMENTS

Sir:

As a part of an investigation of the molecular shape and weight of native and denatured proteins, we have carried out viscosity and diffusion measurements of some undenatured proteins, under carefully controlled experimental conditions. Our viscosity measurements were confined to low protein concentrations, *i. e.*, between 1 and 15 mg. per cc. The specific viscosities of the proteins investigated are independent of the velocity gradient and linear with respect to the protein concentrations up to about 8 mg. per cc. The diffusion measurements were carried out as described previously.[1,2] The apparent shapes of the protein molecules, assuming negligible hydration, were calculated from their specific viscosities with the equation derived by Simha,[3] without the approximation given previously.[3]

(1) Neurath and Saum, *J. Biol. Chem.*, **128**, 437 (1939).
(2) Neurath and Cooper, *ibid.*, in press (1940).
(3) Simha, *J. Phys. Chem.*, **44**, 25 (1940).