17. Determination of the Density Change of Glass by a Sink-Float Method. (II)

Funtamental Study for a Quality Control Method Applicable to Japanese Glass Industry.

Masao Mine, Tamotsu Yamate and *Toyomi Akiyama.*

A sink-float method of measuring small variations of density of glass was studied. As a heavy liquid, the density of which is comparable with that of glass, a water solution of $KI+HgI_2$ was used.

Predetermined temperature coefficient of the density of the liquid was 0.0012g/cc/°C. The equi-density temperatures of the liquid to glass samples were measured with preciseness of 0.1°C and were compared with those of the standard specimens.

The density of glass rod drawn and rapidly cooled in air decreases with decreasing thickness of it, and the difference of density caused by that of thikness disappears by the annealing. The densities of unannealed rods of 4.3±0.2 mm thick increase $(80\mp1)\times10^{-4}$ by the annealing.

If well annealed, the densities of the samples, taken out in any period from the reaching maximum melting temperature over 1400°C to the end of the working, were found to be nearly the same within the range of $\pm2\times10^{-4}$.

Accordingly the density data of unannealed glass rods of the same thickness indicate obviously the variations of qualities of glass melted daily in a pot. As an example, the avarage density of glass rods of 4.3±0.2 mm thick taken daily from a pot in definite position in a direct-fired furnace of a plant for two months long was 2.4885, and the range of density variation of daily samples was $\pm50\times10^{-4}$.

The authors are convinced that this method of measuring density is applicable effectively even to the small scale plants in this country which are operated with direct-fired pot furnaces.

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18. Study on High Dielectric Constant Ceramics. (III)

Electrostrictive and Piezoelectric Effect of $BaTiO_3$ Ceramics.

Kiyoshi Abe and *Tetsuro Tanaka.*

$BaTiO_3$ ceramic has ferroelectric properties in the temperature range below Curie point, and in this temperature range also shows electrostrictive effect. We measured this effect directly by an apparatus similar to those generally used for measuring magnetostriction. The apparatus consists of a moving rod, roller with mirror, scale and telescope etc., and small amount of expansion or contraction is

converted to rotating angle of mirror and magnified as the movement of scale.

$BaTiO_3$ ceramics expand in the direction of applied field and contract in all directions at right angle to the applied field. To measure the coefficient for the lateral contraction, a cylindrical ceramic, of which both inner and outer surfaces are silver-plated, was used.

The amount of contraction increases with applied biasing voltage and it is found that the total decrease in length is about 1×10^{-4} up to a voltage gradient of 20,000 V/cm. The magnitude of electrostriction is ihfluenced not only by field intensity but the time of exposure to field. The effect of time comes out very gradually and it requires $10^2\sim10^5$ seconds to attain to the saturated value. The lower the field intensity drops, the longer the time becomes. When field is reduced to zero, there remains some residual striction, the magnitude of which is also affected by field intensity and time of exposure to field.

$BaTiO_3$ ceramic, that has been exposed to D. C. biasing field and has some residual striction, shows piezoelectric effect. We examined the relations between the piezoelectric sensitivity and applied field intensity or time of exposure to field, and got a result similar to that regarding electrostrictive effect. From our experimental results, it seems that the piezoelectric sensitivity of such materials as mentioned above is proportional of the residual striction remained after removal of field.

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19. Study on High Dieiectric Constant Ceramics. (IV)

Electromechanical Vibration of $BaTiO_3$ Ceramics.

Kiyoshi Abe and *Tetsuro Tanaka.*

$BaTiO_3$ ceramic which has been exposed to D. C. biasing field, has some residual polarization after the field is removed. Such material has piezoelectric properties similar to those of quartz or Rochelle salt. If we examine the frequency characteristic of such polarized ceramic, we can find a resonance spectrum which is attributed to a piezoelectric effect. An experimental study was held in order to know the behavior of such resonance and to derive the frequency constants of these vibrations. About 20 specimens consisted of $BaTiO_3$ ceramics were prepared, half of these were formed like strips and another half rectangular plates. The polarizing field strength was 10,000 V/cm and the time of exposure was half an hour. Using these specimens, the resonant frequencies of longitudinal length mode and thickness mode were measured. The plots of $1/l$ (l is length of strip) and $1/t$ (t is thickness of plate) versus resonant frequencies indicate that these relations satisfy fairly well a linear relation, and it was found that the frequency constant is 225 K. C.-cm for the longitudinal length mode, and 255 K. C.-cm for the thickness mode. Employing