CIRCUIT ANALYSIS OF VANADYL DOPED ZINC LITHIUM BORATE GLASSES

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ABSTRACT
Glasses have been synthesized in the compositional range of \( x \text{ZnO} \bullet (30-x)\text{Li}_2\text{O} \bullet 70\text{B}_2\text{O}_3 \) containing 2.0 mol% of \( \text{V}_2\text{O}_5 \) (\( x = 0.0, 2.0, 5.0, 7.0 \) and \( 10.0 \) mol%) were prepared by standard melt-quench technique. The investigation of the properties has been achieved by analyzing the synthesized glasses for their circuit analysis.

Key words: Equivalent Circuit Analysis

1. INTRODUCTION
Initially, various applications of glasses were within the domain of silicate glasses (a class of oxide glasses). But with the passage of time the other oxide glasses such as phosphate, borate, bismuthate, germanate etc. were also studied with a great deal of academic, scientific, technological interest. The non-silicate glasses proved their justifiable existence to nurture a large portion of scientific community. Out of the above discussed classes of glasses, the borate glasses have their own advantage of studying due to the property of having highest glass forming ability amongst all types of glasses and also due to avoiding crystalinity even at the lowest cooling rates [1]. \( \text{B}_2\text{O}_3 \) can be found in many commercial important glasses and because of the property of boron anomaly it is mostly used as a dielectric material [2]. The higher bond strength, lower cation size and smaller heat of fusion also makes \( \text{B}_2\text{O}_3 \) as a strong glass former [3]. The borate glasses are presumed to be an arrangement of irregular network of \( \text{BO}_3 \) triangles with each oxygen atom being shared by two boron atoms [4]. \( \text{B}_2\text{O}_3 \) is a basic glass former because of its higher bond-strength, lower cation size, smaller heat of fusion and trivalency of boron. In borate glasses, \( \text{B}^{3+} \) ions are triagonally coordinated by oxygen to form glasses easily. The structure of borate glasses has been discussed by several authors on the basis of the results obtained by a variety of experimental techniques such as NMR, Raman spectroscopy, X-ray diffraction, IR spectroscopy, etc. [5-7].

2. EXPERIMENTAL
The starting materials used were analar grade chemicals lithium carbonate (\( \text{Li}_2\text{CO}_3 \)), zinc oxide (\( \text{ZnO} \)), boric acid (\( \text{H}_3\text{BO}_3 \)) and vanadium pentoxide (\( \text{V}_2\text{O}_5 \)) obtained from Loba Chemie. Standard melt-quenching technique was used to prepare glasses. The composition is provided in Table .1. The equivalent circuit analysis has been carried out as a function of temperature over the range of 300-473K with the help of an IM 9000 which is an extension plug-in to HIOKI IM 3570 Impedance Analyzer.

Table .1 Chemical composition and codes used for Zinc lithium borate glasses.

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>ZnO (mol%)</th>
<th>Li_2O (mol%)</th>
<th>B_2O_3 (mol%)</th>
<th>V_2O_5 (mol%)</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>30</td>
<td>70</td>
<td>2</td>
<td>ZLB V1</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>28</td>
<td>70</td>
<td>2</td>
<td>ZLB V2</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>25</td>
<td>70</td>
<td>2</td>
<td>ZLB V3</td>
</tr>
</tbody>
</table>
XRD profiles were recorded at ambient temperature on a Rigaku Miniflex-II X ray diffractometer over the 2θ range of 10-80 degree.

3. CIRCUIT ANALYSIS

Variation of circuit models with temperature for ZLBV1-5 glass samples are shown in Figs. 1 (a-e) respectively. It is observed from Fig. 1 (a) that when no Zinc oxide is present in the ZLBV1 glass sample, it initially follows model A and at temperature 435K it jumps into the model E (i.e Sample ZLBV1 initially in three element model and shift to four element model at 435K) [8]. On adding Zinc oxide, sample ZLBV2 follows model E and at temperature 345K it jumps in to model C (i.e Sample ZLBV2 initially in four element model and shift to three element model at345K ) as shown in Fig. 1 (b). Similary, on adding more zinc oxide to sample ZLBV3 and ZLBV4, initially they follows model E and at temperature 345K and 390K respectively they jumps in to model D [8] as shown in Fig 1(c) and (d). Further, sample ZLBV5 follow model D and again at temperature370K , it jumps in to A as shown in Fig.1 (e) (i.e sample initially and finally in three element model).
(x=0, 2, 5, 7 and 10 mol%) were successfully synthesized as depicted by broad hump without any peak in XRD spectra. Study of the equivalent circuit analysis up to a temperature of 473K shows a significant change in the equivalent circuitry with change in temperature and composition.

REFERENCES

4. CONCLUSIONS
The glasses with composition $x\text{ZnO}(30-x)\text{Li}_2\text{O}70\text{B}_2\text{O}_3$ containing 2.0 mol% of $\text{V}_2\text{O}_5$