An optical perspective on the thermal-activated ionic migration state and ionic jumping distance in glass

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Fig. S1 DSC curves of the Na SG and the K-Na SG.

Fig. S2 The Ln–1/T plot of the (a) K-Na SG, (b) K-Na SG-80 °C and (c) K-Na SG-580 °C.

Fig. S3 EPMA images and the elemental line-scanning images of the (a, e) K-Na SG, (b, f) K-Na SG-80 °C, (c, g) K-Na SG-200 °C, and (d, h) K-Na SG-580 °C.
Fig. S4 Permittivity of (a) K-Na SG and (b) K-Na SG-200 °C as a function of frequency at different temperatures.

Fig. S5 $^{29}$Si MAS NMR spectra of K-Na glass samples (circles), the integrated areas (black line) and the Gaussian fits for each site.

The specific calculation process for the initial distance $D$ between mobile Na$^+$ and Er$^{3+}$:

\[
W(\text{K}_2\text{O})=19.08\% \quad W(\text{Er}_2\text{O}_3)=2.85\% \quad \rho=2.79 \text{ g/cm}^3
\]

\[
N(\text{Na}^+) = 2N_A \frac{\rho \cdot W(\text{Na}_2\text{O})}{M(\text{Na}_2\text{O})} = 2 \times 6.02 \times 10^{23} \text{/(mol)} \times \frac{2.79 \text{ (g/cm}^3) \times 0.1908}{61.97 \text{ (g/mol)}} = 1.03 \times 10^{22} \text{/(ion/cm}^3) \\
N(\text{Er}^{3+}) = 2N_A \frac{\rho \cdot W(\text{Er}_2\text{O}_3)}{M(\text{Er}_2\text{O}_3)} = 2 \times 6.02 \times 10^{23} \text{/(mol)} \times \frac{2.79 \text{ (g/cm}^3) \times 0.0285}{382.51 \text{ (g/mol)}} = 2.50 \times 10^{20} \text{/(ion/cm}^3) \\
N(\text{Na}^+) + N(\text{Er}^{3+}) = 1.06 \times 10^{22} \text{/(ion/cm}^3)
\[
\frac{1}{N(Na^+) + N(Er^{3+})} = 9.434 \times 10^{-23} (cm^3/ion) = 94.34(\text{Å/ion})
\]

\[
\frac{4}{3} \pi r^3 = 94.34(\text{Å})
\]

\[
r = 2.8(\text{Å})
\]

\[
D = 2r = 5.6(\text{Å})
\]

**Table S1** The jump distance \(d\) calculated by using the conductivity at different temperatures

<table>
<thead>
<tr>
<th>Glass sample</th>
<th>The jump distance (d) at different temperatures (Å)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>250°C</td>
</tr>
<tr>
<td>Na SG</td>
<td>1.9</td>
</tr>
<tr>
<td>K-Na SG</td>
<td>2.0</td>
</tr>
<tr>
<td>K-Na SG-200 °C</td>
<td>2.1</td>
</tr>
</tbody>
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