Dynamics of Benzimidazole Ethylphosphonate: A Solid-State NMR Study of Anhydrous Composite Proton-Conducting Electrolytes

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Supplementary Document

1. Differential scanning calorimetry data for pristine solid acid

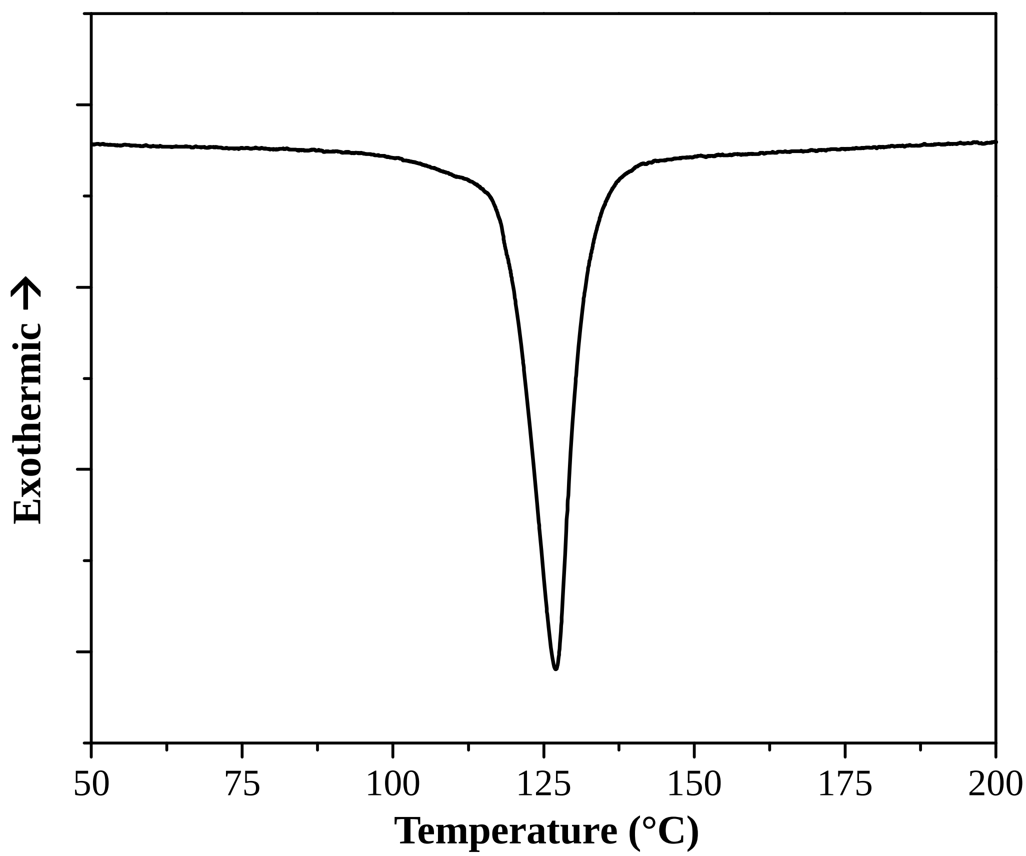


Figure S1. Differential scanning calorimetry for Bi-ePA: T_m= 127 °C

2. Ionic conductivity analysis and calculation

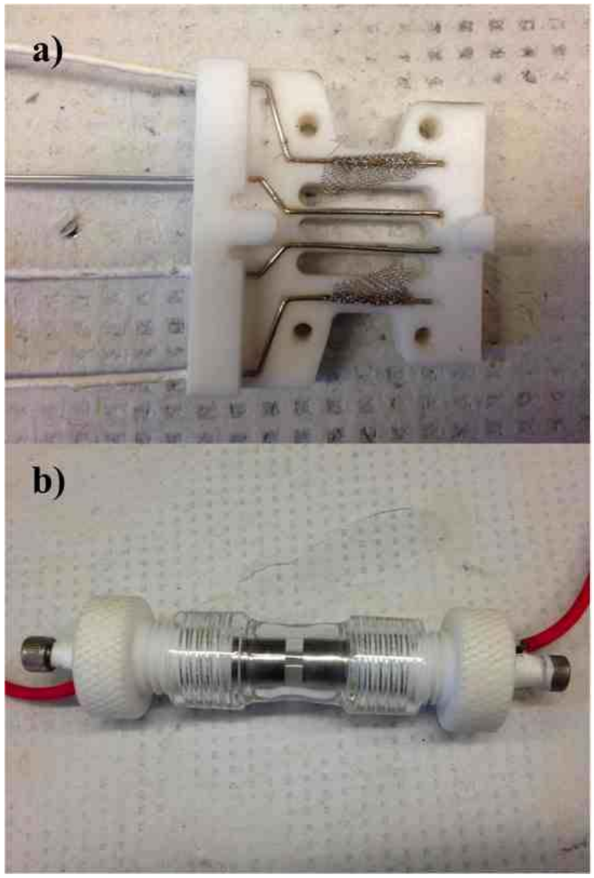
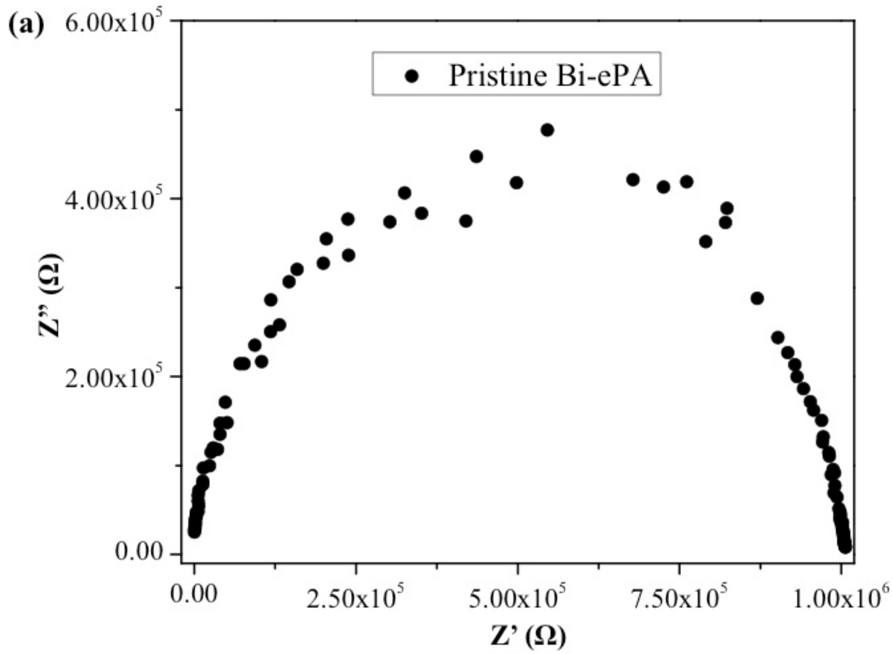


Figure S2. The impedance spectroscopy cell configurations used in this study. (a) The four-probe sample cell configuration with platinum electrodes. (b) Through-plane cell configuration with platinum electrodes.



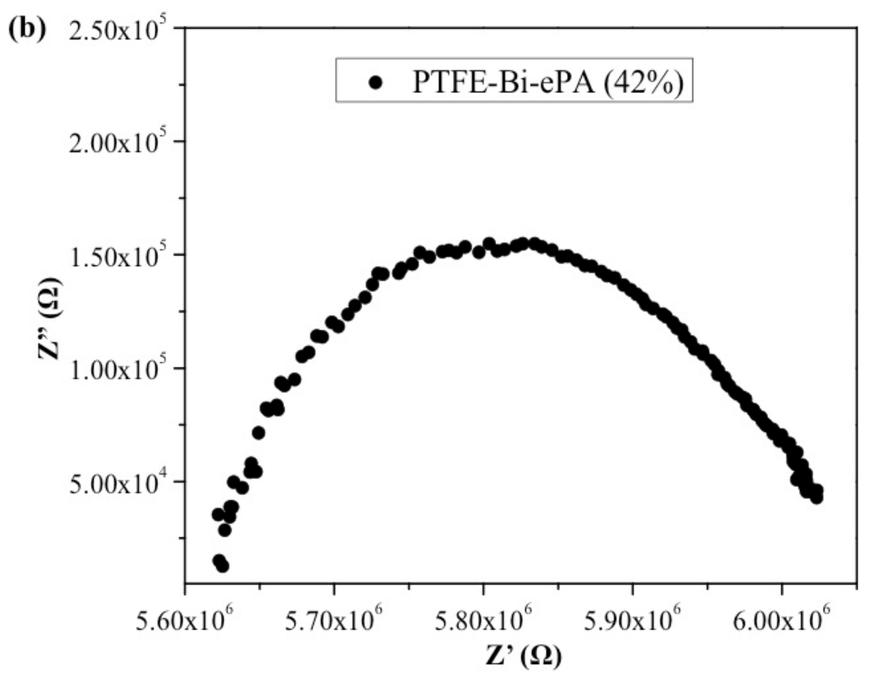


Figure S3. Nyquist plots at 90 °C of (a) a powder-compressed pellet of the Bi-ePA pristine salt and (b) 42 % loading membrane-salt composite. A Nyquist plot has the complex impedance on the y-axis with the real impedance on the x-axis.

The resistance of the material, R_m, can be extracted using ZView® software from Scribner Associates by fitting the data with semi-circular functions, which is the diameter of the semi-circle along Z', x-axis. The conductivity, σ, is defined as the inverse of resistivity, ρ.

$\sigma = \frac{1}{\rho}$, and ρ is defined as $R \times \frac{A}{l}$,

where R is the resistance of the material, A is the cross-section area of the material, and l is the length of the material.

In the in-plane four-probe cell configuration, the conductivity is calculated by,

$\sigma = \frac{d}{R_m}$, where d is the thickness of the powder-pressed pellet.

In the through-plane cell configuration, the conductivity is calculated by,

$\sigma = \frac{l}{R_m \times A} = \frac{l}{R_m \times w \times d}$, where w is the width of the strip of the composite sample and d is the thickness of the composite sample.