Supplementary information

Structural and dielectric properties of Cobaltacarborane Composite Polybenzimidazole Membranes as solid polymer electrolytes at high temperature

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Fig. S1 shows a schematic representation of the PBI matrix with M[COSANE] and M'[TPB].

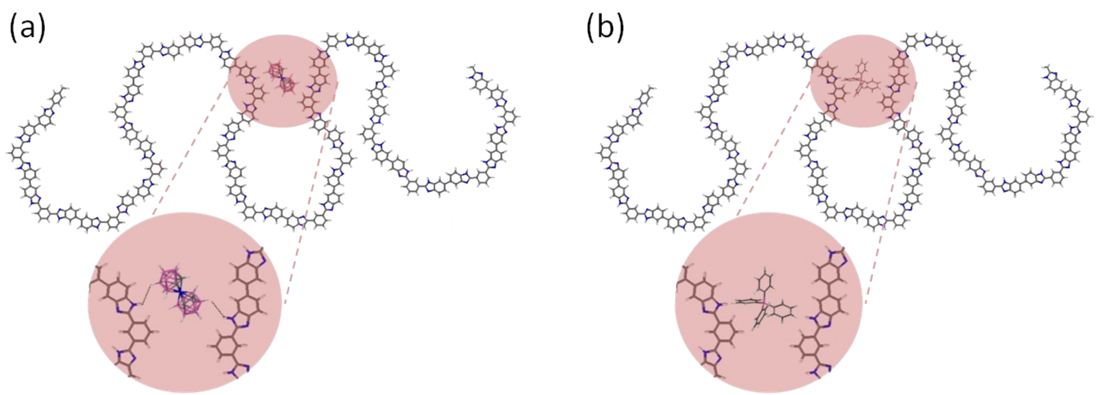

Fig. S1 Schematic representation of PBI composite membranes containing metallacarborane, $[Co(C_2B_9H_{11})_2]^-$, and tetraphenylborate, $[B(C_6H_5)_4]^-$.

Fig. S2 shows the FTIR spectra of the different composite membranes of metallacarboranes (M[COSANE] (M = Li^+, Na^+, H^+)) and tetraphenylborate (M'[TPB] (M' = Li^+, Na^+) in the range of 4000–600 cm^{-1}.

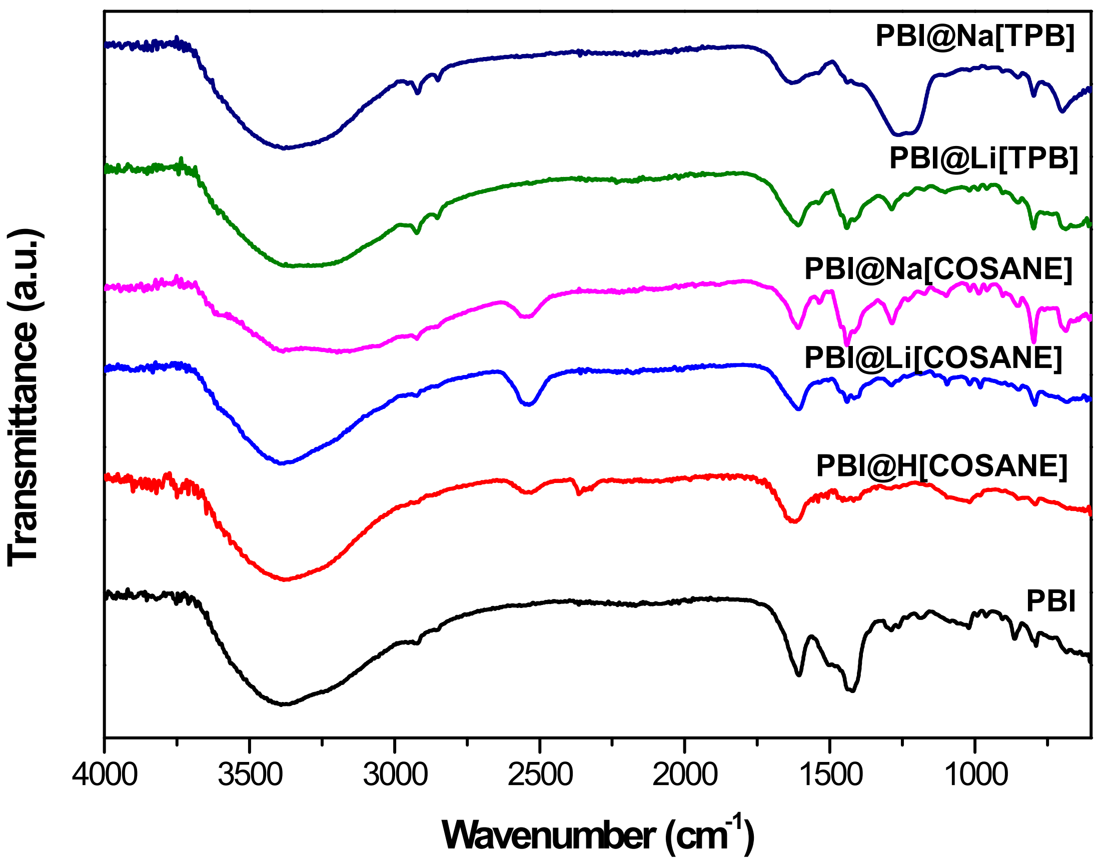

Fig. S2 FTIR spectra of PBI pure membrane and PBI@H[COSANE], PBI@Na[COSANE], PBI@Li[COSANE], PBI@Li[TPB] and PBI@Na[TPB] composite PBI membranes.

Fig. S3 shows the conductivity σ´ versus frequency at several temperatures for the sample PBI@Na[COSANE]. As we can see the real part of the conductivity is characterized by a plateau regime that directly yields the dc conductivity. In this regime σ'(ω) is identical to the bulk dc conductivity σ_{dc} (i.e. σ_0), where the conductivity of the composite PBI should be determined, reflecting long-range ion transport. This behavior is similar to the typical curves showed for the other samples in Fig. 4.

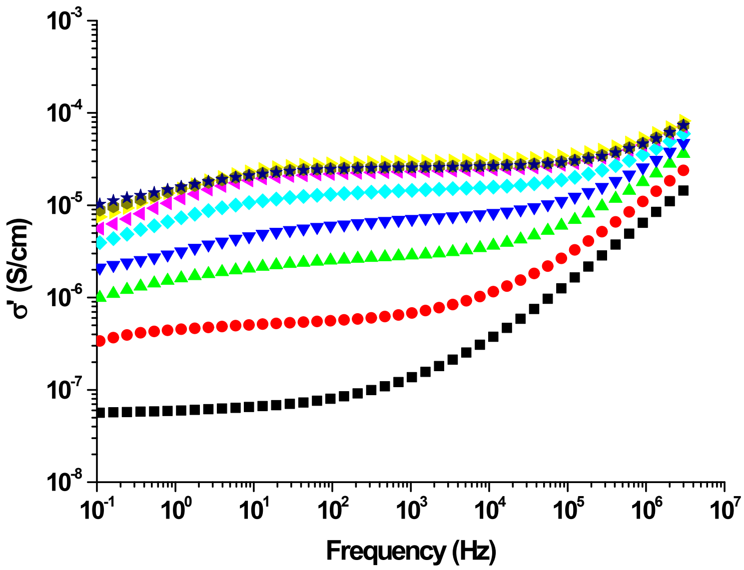

Fig. S3 Double logarithmic plot of the real part of the conductivity, σ', versus frequency for the sample PBI@Na[COSANE] at several temperatures: 20 ºC (■), 40 ºC (●), 60 ºC (□), 80 ºC(❑), 100 ºC (◆), 120 ºC(♦), 140 ºC (◆), 160 ºC (⇘) and 180 ºC (✶).

As we can see in the region of moderate frequencies a plateau has been observed. As we can see from Fig. S3, the real part of the conductivity in dry conditions varies from $6x10^{-8}$ S/cm at 20 ºC to around $3x10^{-5}$ S/cm at 180 ºC.

Fig. S4 shows the plot of double logarithmic of σ" versus frequency in the complete range of temperatures studied for PBI@H[COSANE].

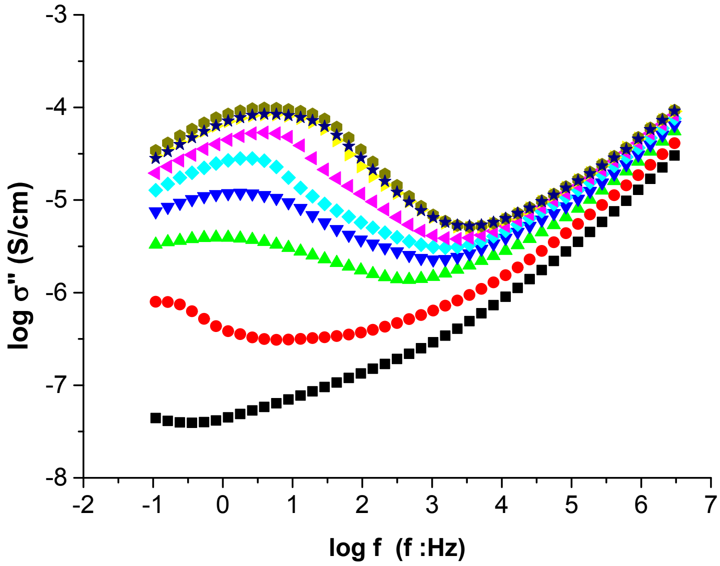

Fig. S4. Double logarithmic plot of imaginary part of the conductivity versus frequency at 20 ºC (■), 40 ºC (●), 60 ºC (□), 80 ºC(❑), 100 ºC (◆), 120 ºC(♦), 140 ºC (◆), 160 ºC (⇘) and 180 ºC (✶) for PBI@H[COSANE].

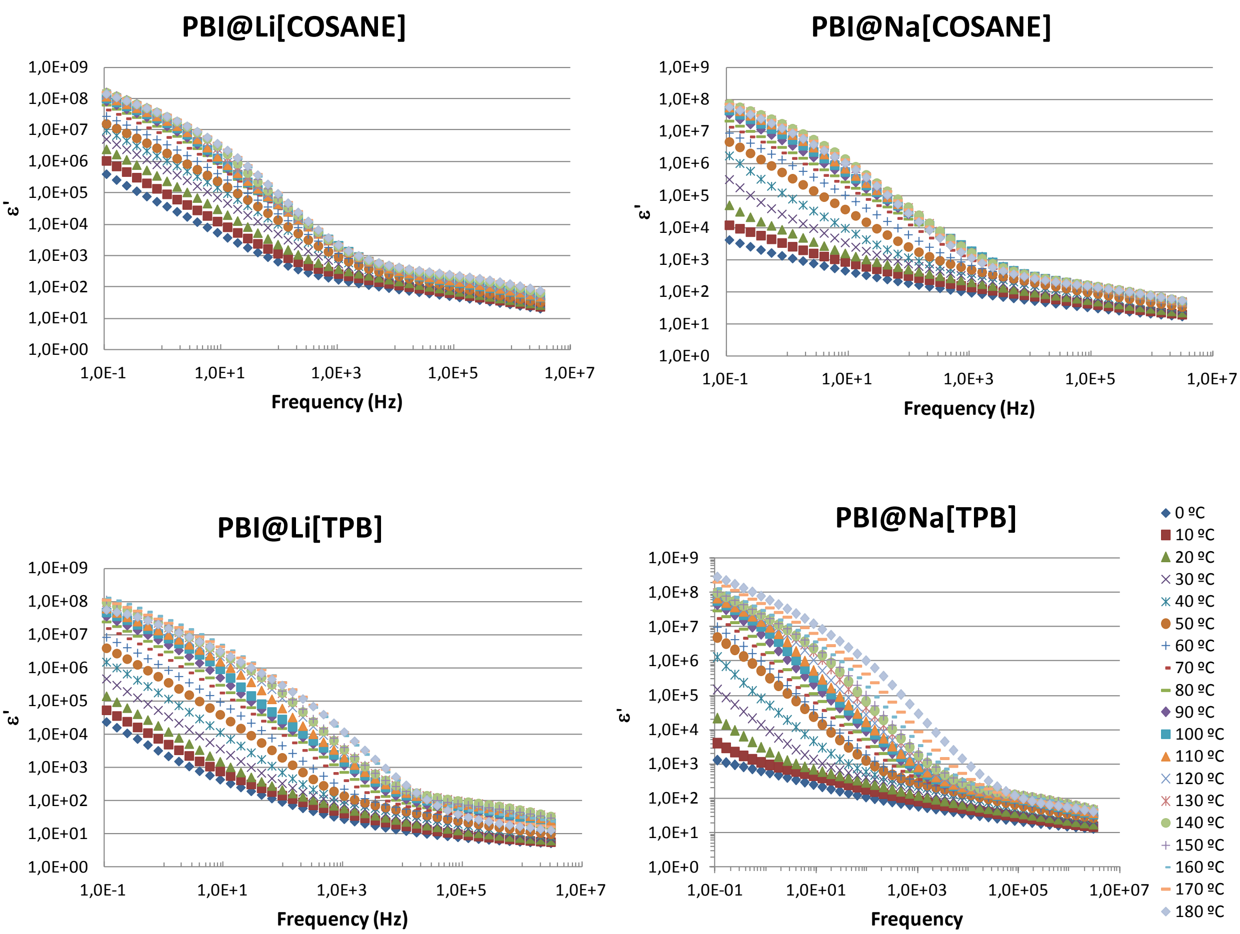

Fig. S5. Real part of the dielectric permittivity versus frequency measured experimentaly.

From the plots shown in Fig. S5 we can see that dielectric constant $\varepsilon'(\omega)$ do not contain clear plateaus from which we can determine ε_s experimentaly.