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Supporting Information for:

Gating Effects of Conductive Polymeric Ionic Liquids

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Characterization methods

The X-ray diffraction (XRD) was measured by Bruker AXS D8 ADVANCE X-ray diffractometers. The magnetic properties were carried out in Quantum Design superconducting quantum interference device (SQUID), the wavelength of the x-ray source is 1.6518 Å.

Small-angle X-ray scattering (SAXS) experiments were carried out under vacuum with a rotating copper-anode X-ray generator (Nanostar, Bruker AXS), Cu-Ka radiation (wavelength 0.1542 nm) monochromatized and collimated from crossed Goebel mirrors and a 2-D position sensitive detector (Vantec 2000). The samples were placed between commercial aluminum foils. With a sample to detector distance of 108 cm an accessible q-range from 0.06 to 2.8 nm^{-1} was obtained.

Differential scanning calorimetry (DSC) was conducted on a Perkin Elmer Pyris Diamond instrument. The glass transition temperatures (T_g) were determined by cooling the polymers at -100 ^oC and then heating up to 200 ^oC (10 $^oC \cdot min^{-1}$), and repeating this process. The T_g was taken as the midpoint of a small heat capacity change by heating from amorphous glass to a liquid state in the 2nd cycle.

Broadband Dielectric Spectroscopy (BDS) measurements are carried out using a high-resolution NOVOCONTROL Alpha-Analyzer combined with a Quatro temperature controller (ensuring an absolute accuracy of ≤0.1K) in a wide frequency (10mHz-10MHz) and temperature range (100-450K). The sample cell used for the PIL under study consists of two brass electrodes (lower: spectrometer ground plate, diameter d = 40mm / upper: diameter d = 10 mm) which are separated by 3 glass fiber spacers (diameter d = 50µm) arranged in parallel. To evaporate remaining solvents (that might react as plasticizer) and water that contributes significantly to the conductivity and several relaxation processes due to its dissociation into H^+

and $(OH)^-$ and its strong dipole moments (in the weakly bond, strongly bond, adsorbed and free state), the sample cell is annealed at 150 °C for about 24 h within an oil-free high-vacuum chamber (1e-6mbar). During this time the sample material is *not* covered by the top electrode. Subsequently, while it is still in the liquid state and kept under vacuum conditions the upper electrode is turned down and brought in contact with the material under study, before the complete cell is slowly cooled down and flushed with inert dry argon gas. The transfer from the vacuum chamber to the cryostat of the spectrometer as well as the measurements take place in a water free nitrogen atmosphere.

Alternating current chip-calorimetry (ACC) was employed using a setup from the group of Prof. Schick at the University in Rostock as described in ref [21] with XEN-39390 chips from Xensors Integration. The measurements are carried out in a temperature range between -100 and 100 ^oC with heating and cooling rates of 1 ^oC/min and operating frequencies in a range of 100 mHz and 10 kHz. The glass transition temperatures at certain frequencies are determined as midpoint of the step in the magnitude of the measured voltage that is proportional to the real part of the complex heat capacity.

$SrCoO_{2.5}$ thin film preparation of ionic liquid gating using obtained PILs. $SrCoO_{2.5}$ thin film, 40 nm thick, was grown on $SrTiO_3$ (001) substrates at 725 ºC in an oxygen pressure of 5×10^{-4} mbar using pulsed laser deposition. After deposition, the film was cooled to room temperature in the same oxygen atmosphere. Before applying gate voltages, POILs was melted at ~150 °C and smeared on the surface of the $SrCoO_{2.5}$ thin film and lateral golden electrode. Gate voltages were applied by Keithley 2450 source meter in a probe station.

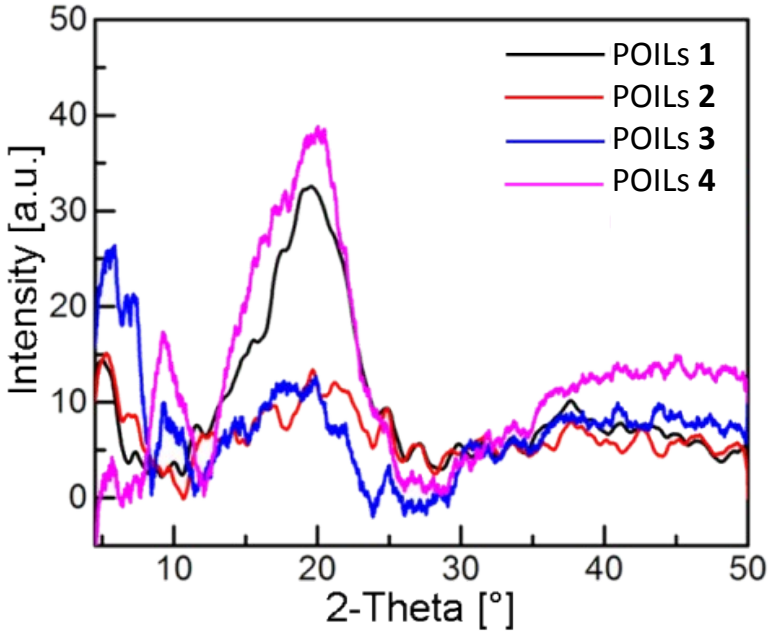

Figure S1: XRD pattern different POILs at room temperature.

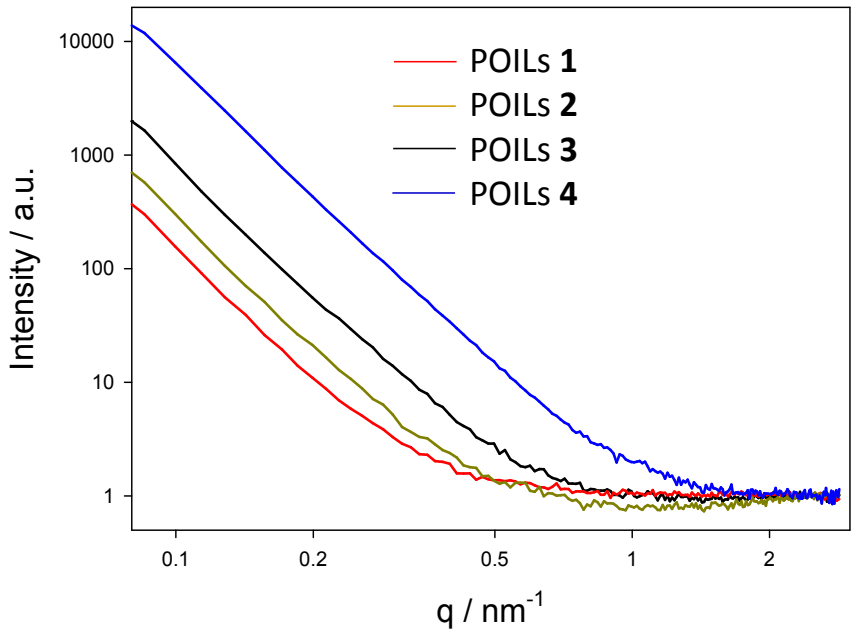

Figure S2: One-dimensional SAXS profiles recorded at room temperature.