Supporting Information

High and Stable Ionic Conductivity in 2D Nanofluidic Ion Channels between Boron Nitride Layers

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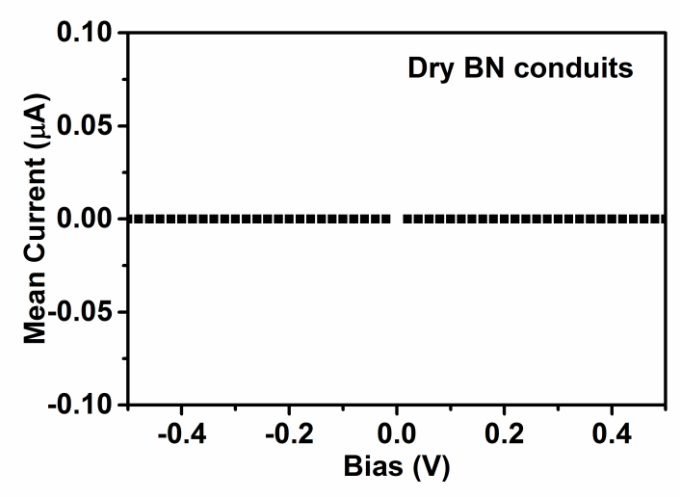

Figure S1. *I*−*V* curves obtained on dry BN conduits. There was no meaningful current recorded, indicating that the dry conduits is not conductive within the voltage range of -0.5 – 0.5 V.

The SEM images of two BN conduits with different thicknesses and their corresponding *I*−*V* curves are shown in Figure S2 (a–d). The two conduits have similar size with a length and width around 14 mm and 6 mm respectively. Conductance of the two conduits are shown in Figure S2 (e–f), suggesting the thicker conduits have a larger conductance and the conductance is proportional to the thickness. However, the conductivities of the two conduits are still highly consistent in the NaCl concentration range (10^{-6}–0.05 M).

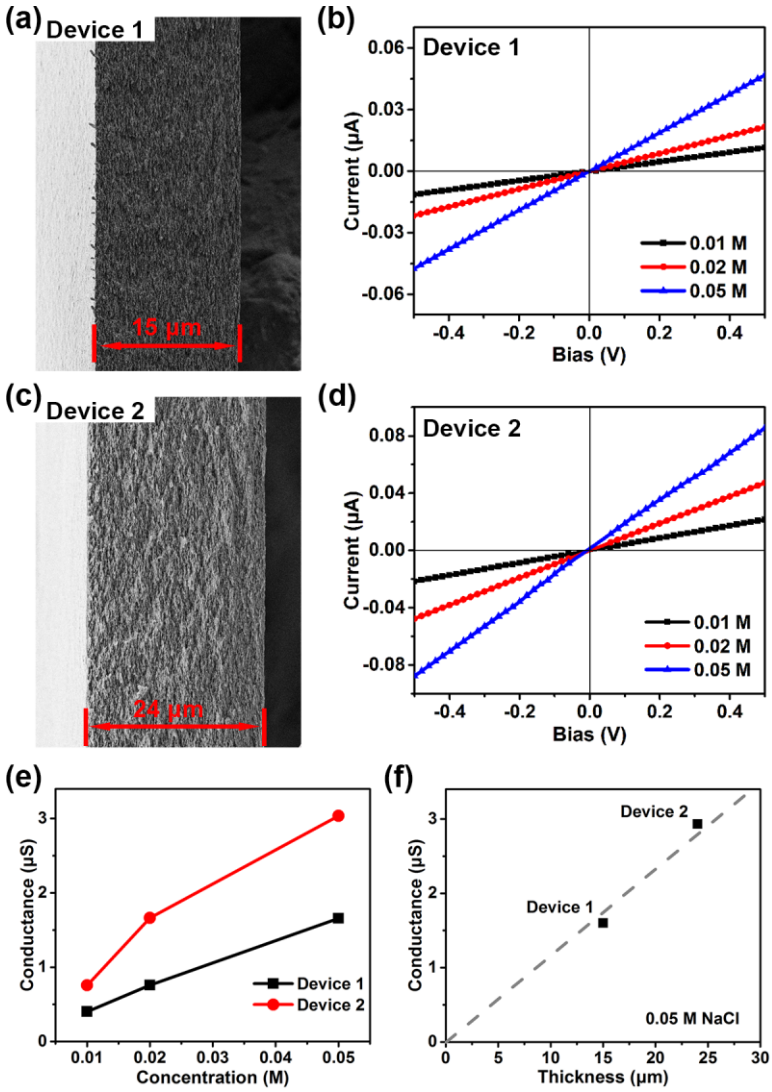

Figure S2. BN conduits with different thicknesses, the corresponding *I*−*V* curves and the conductance obtained in NaCl concentrations of 0.01, 0.02 and 0.05 M at a pH ~7. (a) SEM image of BN conduits with a thickness of ~15 μm and (b) its corresponding *I*−*V* curve. (c) SEM image of BN conduits with a thickness of ~24 μm and (d) its corresponding *I*−*V* curve. (e) Conductance of the two different conduit devices and (f) plot of their conductance as a function of thickness.

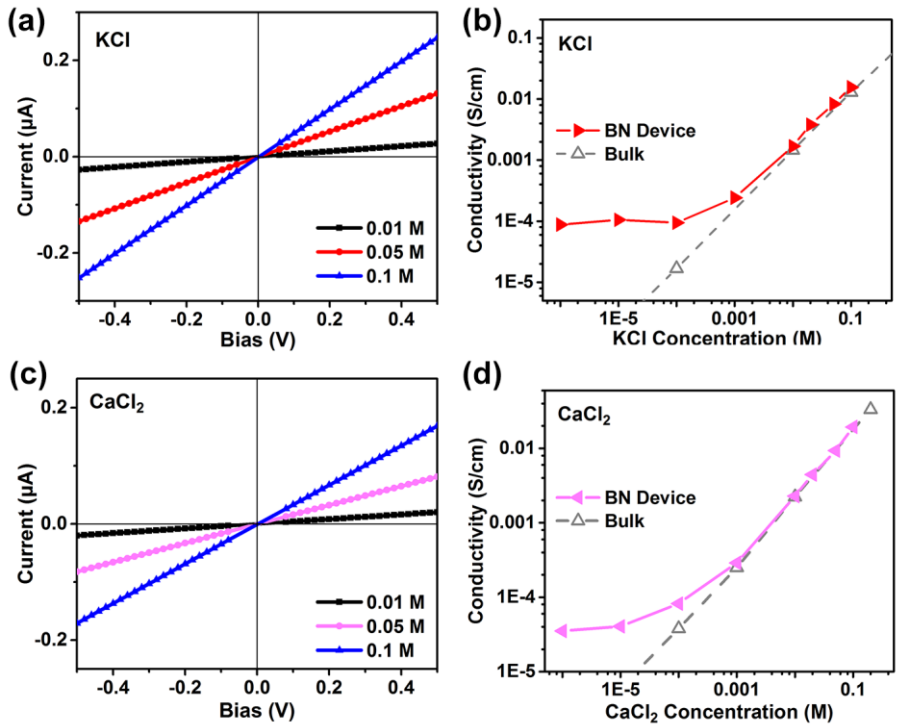

Figure S3. (a) *I*−*V* curves obtained at KCl concentrations of 0.01, 0.05 and 0.1 M. (b) Ionic conductivity as a function of KCl concentration with pH ~7. (c) *I*−*V* curves obtained at $CaCl_2$ concentrations of 0.01, 0.05 and 0.1 M. (d) Ionic conductivity as a function of $CaCl_2$ concentration with pH ~7.

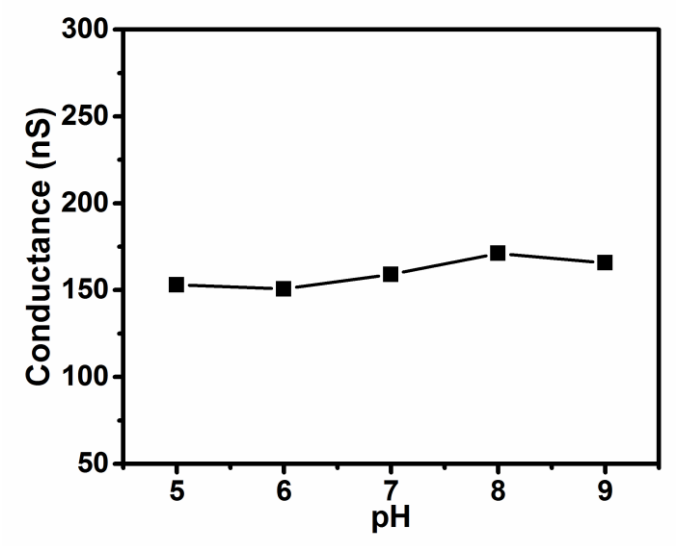

Figure S4. Conductance measured in 0.1 M KCl with different pH from 5 to 9. No clear dependence of conductance on pH has been found.

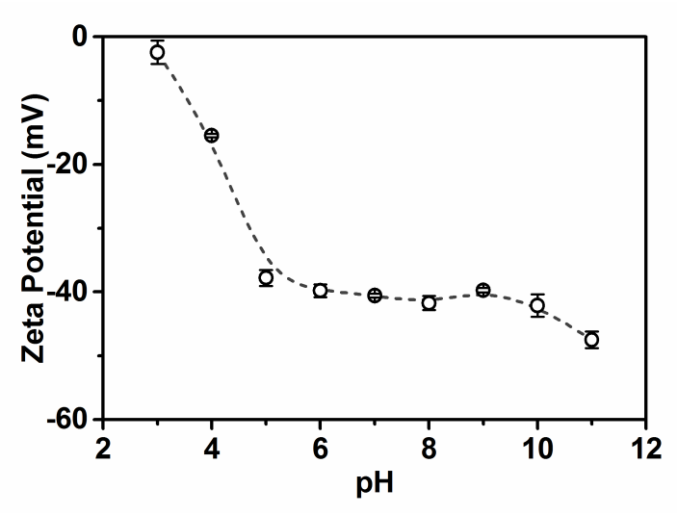

Figure S5. Zeta potential of the BN nanosheets in colloidal dispersion in a pH range of 3–11 in 1 mM KCl electrolyte.

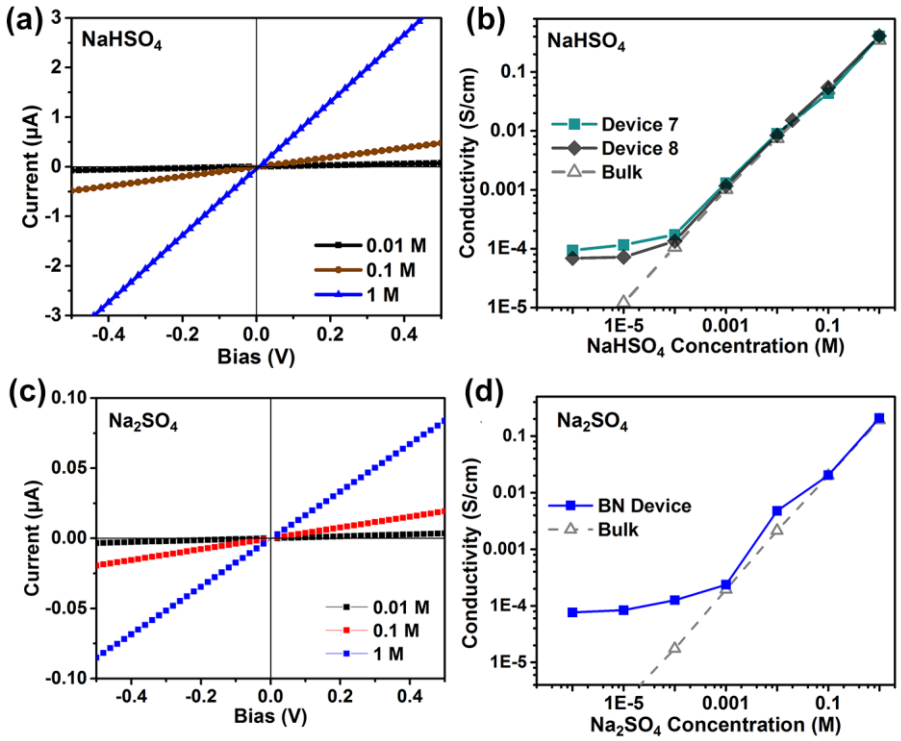

Figure S6. The results from Na_2SO_4 and $NaHSO_4$ solutions show differences in conductivity with the presence of protons. (a) *I*−*V* curves obtained at $NaHSO_4$ concentrations of 0.01, 0.1 and 1 M. (b) Ionic conductivity as a function of $NaHSO_4$ concentration. (c) *I*−*V* curves obtained at Na_2SO_4 concentrations of 0.01, 0.1 and 1 M. (d) Ionic conductivity as a function of Na_2SO_4 concentration.

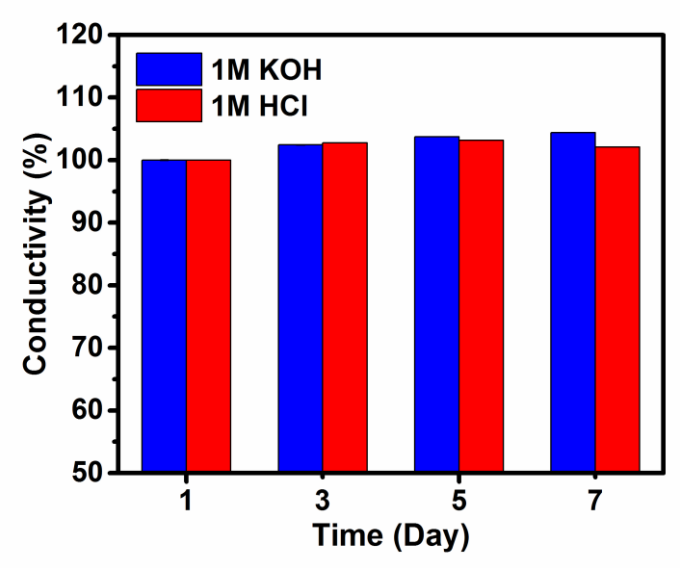

Figure S7. Variation of ionic conductivity of the BN conduits in 1 week measured in 1 M KOH and 1 M HCl.

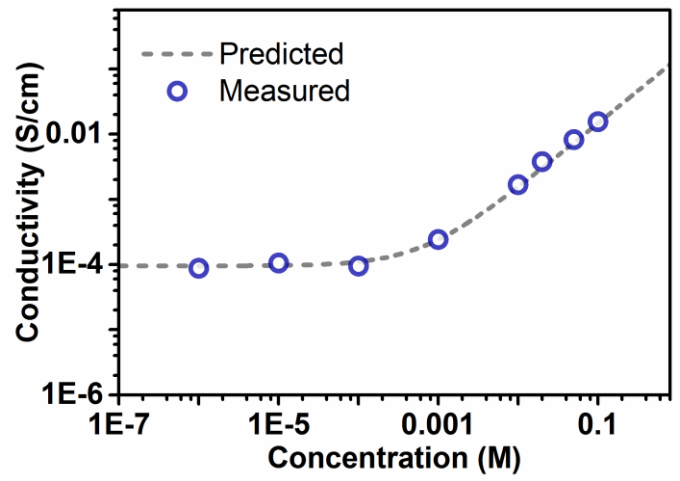

Figure S8. Conductivity predicted from equation (1) and the conductivity measured in KCl solutions at various concentrations.