Unusual hyperpolarization observations in polyacrylate gels with monovalent salts

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Previously, we have verified that poly(acrylate) gels exhibit electrical potentials in the range normally afforded by living cells. However, we have unexpectedly found that bathing poly(acrylate) gels in aqueous solutions of monovalent salts such as KH_2PO_4 in a narrow concentration range (ca. 8-16 mM) leads to a softening of gels without measurable volume changes. Moreover, electrical potentials of the gels in KH_2PO_4 solutions measured using standard electrophysiological methods show an abrupt increase in gel potential (to ca. -100 mV) concomitant with the mechanical softening transition. This is also correlated to a decrease in modulus at this transition (shown through both elastic and compression modulus). Such electrical 'hyperpolarization' has been observed in living systems but never in inanimate gels. Magnetic resonance imaging experiments reveal an increase in water spin-spin relaxation time (T_2) in the same range of KH_2PO_4 concentration, suggesting increased water mobility in the mechanical and electrical transition region. Small angle neutron scattering also demonstrate a structural change in mesh size at this transition, suggesting a collapse and release of the chains. This leads us to suggest additional considerations toward a more comprehensive theory of polyelectrolytes, namely ion site and affinity.