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Room-temperature Salt Solutions L-VI-VII Icing by Compression

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We show that transiting NaX/H₂O solutions of 0.016 molar concentration (X = F, Cl, Br, I) [1, 2] and NaI/H₂O of different concentrations into an ice VI phase and then into an ice VII at 298 K proceeding in different ways. The solute-type-resolved critical pressures PC1 and PC2 increases simultaneously in the Hofmeister series order: X = I > Br > Cl > F > 0; comparatively, concentration-resolved PC1 increases faster than the PC2 that remains almost constant at higher NaI/H₂O concentration. The PC1 moves along the Liquid-VI phase boundary and merges to PC2 at the Liquid-VI-VII phase junction of 350 K and 3.05 GPa. Observations confirmed that the solute solvation creates electric fields that lengthen and soften the O:H nonbonds and meanwhile shorten and stiffen the H-O bonds [3, 4], being the same to molecular undercoordination [5-7]. Compression, however, does it oppositely [8]. Therefore, compression recovers the electrification-deformed O:H-O bond first and then proceeds to the phase transitions. The concentration-raised anion-anion interaction weakens the electric field within the hydration shell, which discriminates the effect of NaI/H₂O concentration from solute types at an identical concentration.

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Significance statement

Salting and compressing have opposite effect on the H-O bond energy that determines the critical pressures for room-temperature liquid-VI-VII phase transition of solutions.

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