Supplementary information

The supplementary information addresses five different references of Raman spectra of groups; SO_4^{2-}, Cl^-, NO_3^-, CO_3^{2-}, and $CH_3SO_3^-$. Raman spectra are taken from reference specimens of simple salts such as reagent-grade chemicals, 99.5wt% Na_2SO_4 (Kishida Chemical), 98.0wt% $Na_2SO_4 \cdot 10H_2O$ (Kishida Chemical), 98.0wt% $NaHSO_4 \cdot H_2O$ (Kishida Chemical), 99.5wt% $MgSO_4 \cdot 7H_2O$ (Kishida Chemical), 98.0wt% $CaSO_4 \cdot 2H_2O$ (Kishida Chemical), $CaSO_4 \cdot 0.5H_2O$ (Kanto Chemical), 99.5wt% $(NH_4)_2SO_4$ (Kishida Chemical), 99.5wt% NaCl (Kishida Chemical), 98.0wt% $MgCl_2 \cdot 6H_2O$ (Kishida Chemical), 99.0wt% $NaNO_3$ (Kishida Chemical), 99.0wt% $Mg(NO_3)_2 \cdot 6H_2O$ (Kishida Chemical), 98.5wt% $Ca(NO_3)_2 \cdot 4H_2O$ (Kishida Chemical), 99.0wt% NH_4NO_3 (Kishida Chemical), 99.5wt% Na_2CO_3 (Kishida Chemical), 99.0wt% $Na_2CO_3 \cdot 10H_2O$ (Kishida Chemical), 99.5wt% $CaCO_3$ (Kishida Chemical), 98wt% CH_3SO_3Na (Alfa Aesar), 99wt% $(CH_3SO_3)_2Mg$ (Daniels Fine Chemicals), 98wt% CH_3SO_3K (Tokyo Kasei Kogyo), and 98wt% $(CH_3SO_3)_2Ca$ (Tokyo Kasei Kogyo).

Raman spectra of $Na_2SO_4 \cdot 7H_2O$ and $MgSO_4 \cdot 11H_2O$ are synthesized using previous methods [S1, S2], respectively. $NaCl \cdot 2H_2O$, $MgCl_2 \cdot 12H_2O$, $CH_3SO_3Na \cdot nH_2O$, $(CH_3SO_3)_2Mg \cdot nH_2O$, $CH_3SO_3K \cdot nH_2O$, $(CH_3SO_3)_2Ca \cdot nH_2O$ are synthesized at eutectic concentration and measured below the eutectic temperature.

Reference

[S1] Hamilton, A., Hall, C., Sodium sulfate heptahydrate: a synchrotron energy-dispersive diffraction study of an elusive metastable hydrated salt, J. Anal. At. Spectrom., 2008, 23, 840-844.

[S2] Genceli, F.E., Lutz, M., Spek, A.L., Witkamp, G-J., Crystallization and Characterization of a New Magnesium Sulfate Hydrate $MgSO_4 \cdot 11H_2O$, Cryst. Growth. Des., 2007, 7(12), 2460-2466.

Figure A. Reference Raman spectra of SO_4^{2-} salts. a. Na_2SO_4; b. $Na_2SO_4 \cdot 7H_2O$ [S1]; c. $Na_2SO_4 \cdot 10H_2O$; d. $NaHSO_4 \cdot H_2O$; e. $MgSO_4 \cdot 7H_2O$; f. $MgSO_4 \cdot 11H_2O$ [S2]; g. $CaSO_4 \cdot 2H_2O$; h. $CaSO_4 \cdot 0.5H_2O$; i. $(NH_4)_2SO_4$.

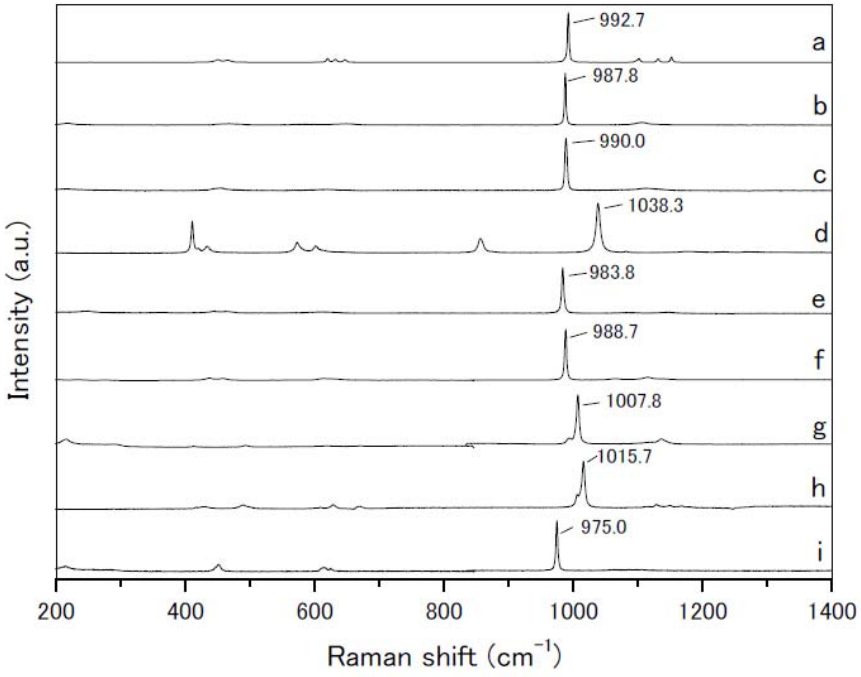

Figure B. Reference Raman spectra of Cl^- salts. a. $NaCl \cdot 2H_2O$; b. $MgCl_2 \cdot 6H_2O$; c. $MgCl_2 \cdot 12H_2O$.

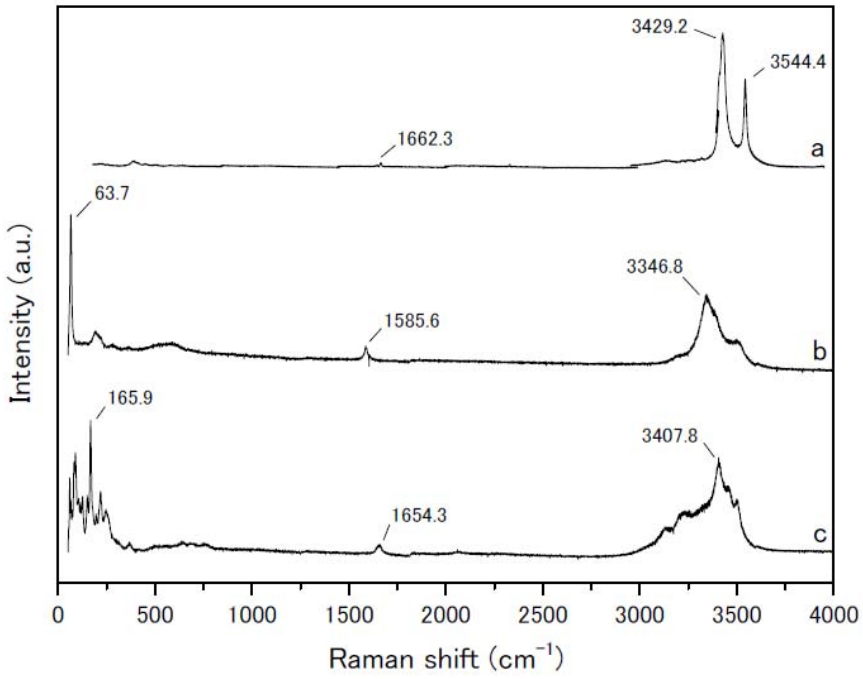

Figure C. Reference Raman spectra of NO_3^- salts. a. $NaNO_3$; b. $Mg(NO_3)_2 \cdot 6H_2O$, c. $Ca(NO_3)_2 \cdot 4H_2O$; d. NH_4NO_3.

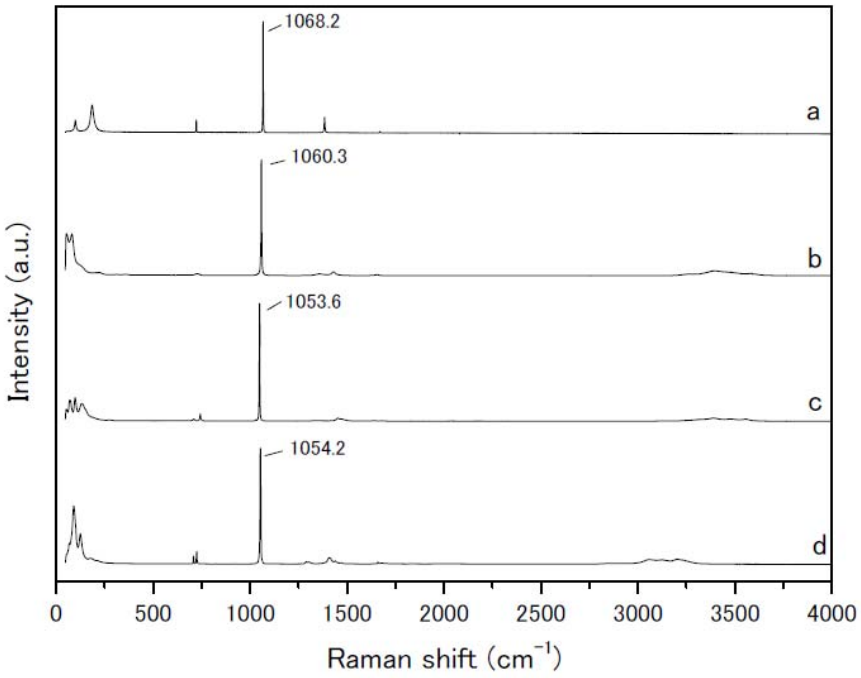

Figure D. Reference Raman spectra of CO_3^{2-} salts. a. Na_2CO_3; b. $Na_2CO_3 \cdot 10H_2O$; c. $CaCO_3$.

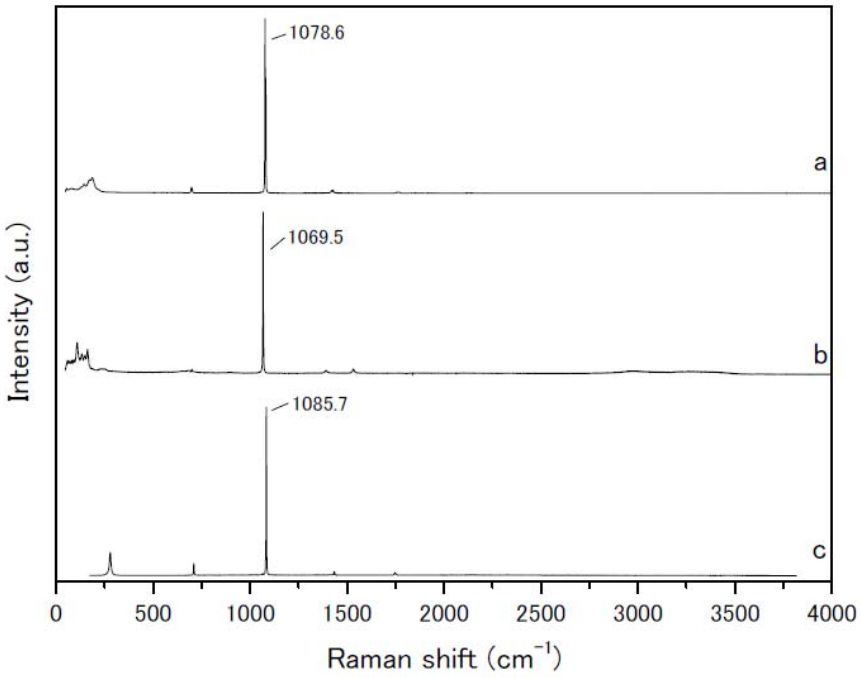

Figure E. Reference Raman spectra of $CH_3SO_3^-$ salts. a. $CH_3SO_3Na \cdot nH_2O$; b. $(CH_3SO_3)_2Mg \cdot nH_2O$; c. $CH_3SO_3K \cdot nH_2O$; d. $(CH_3SO_3)_2Ca \cdot nH_2O$.