Solubility Control of Inorganic Salts by the Cooperative Solvation of Polyethers

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Summary

The purpose of this study is to control the solubility of a series of inorganic salts by the unique cooperative solvation force of polyethers.

Polyethers, represented by the poly(ethylene oxide) (PEO), can solubilize a lot of inorganic salts without the aid of low-molecular-weight solvents. It has been found by us that some salts were crystallized by heating the corresponding salt/PEO solution. This negative temperature dependence in the salt solubility was observed only when a specific couple of solute and solvent. There is no solvent which shows negative temperature dependence in solubility of such a lot of different salts since then. This unique crystallization was found only when the salts have high lattice energy and larger cation. Such salts are analyzed not to form a complex with PEO. The terminal hydroxyl groups of the PEO was therefore revealed to have an important role to solubilize the salts through strong ion-dipole interaction force. This unique behavior of polyethers is comprehensible as the entropic effect. The cooperative coordination of the terminal hydroxyl groups to the cation was weaken by heating through the thermal motion of the chains, and the cation turned less soluble because of weaker interaction of the terminal hydroxyl groups. This weakened entropic coordination may be the reason of the negative temperature dependence in salt solubility in PEO. The threshold of the lattice energy for the crystallization by heating was determined for salts having different alkali metal cations. This threshold was revealed to be controllable by the polarity of the applied polyethers.

The minimum degree of polymerization of polyethers for the negative temperature dependence of the solubility of some alkali metal salts was analyzed to depend on the cation radius. Longer PEO oligomer chain was required for the salt having larger cation radius.

These new results are hoped to lead a new method of salt purification. energy was crystallized from the mixture.