

Effect of alkali metals ions on sol-gel transformation in solution of hydroxypropylcellulose

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Motivation

The sol-gel transformations in the water solutions of hydroxypropylcellulose (HPC) are widely known, but they still are in field of intensive researches. The peculiarity of these solutions is their ability to change considerably their optical, rheological and other physical properties under influence of different external factors. Considerable scientific interest is caused by demand of modern technologies of the new type of materials, so-called "smart materials". Physical and chemical properties of "smart materials" can be tuned by changes of certain parameters, such as temperature, pH level, electrical and magnetic fields, etc.

The HPC-water systems could be used as example of the systems of this sort due to formation of

aggregates of hydroxypropylcellulose with different size and shape, highly sensitive to temperature, pH and presence of electrolytes. So, addition of electrolytes in HPC-water solutions leads to significant changes in their electrical properties and causes influence on sol-gel transformations.

The aim of the present work is to study the influence of alkali metals ions (IA group) on the physical properties of the solution and sol-gel transformations in the HPC-water solution. The measurements of conductivity, viscosimetry, dynamic light scattering (DLS) method, turbidimetry, absorption and luminescence spectroscopy were used to characterize systems under study.

Materials

Aqueous solutions of Hydroxypropyl cellulose (Alfa Aesar, M.W. 100,000) with concentrations of 0.2%, 1% and 2% were used for the study. To prepare an aqueous solution of HOC with ions, ions of alkali metals of the 1st group (chlorides of Li, Na, K, Rb, Cr) were used. The molar concentration of salt in each sample was the same and was 0.154 mol/l.



Experimental results



The transparency of a 2% (wt.) aqueous solution of hydroxypropyl cellulose depending on its temperature and the presence of group I alkali metal ions.



Temperature dependences of the dynamic viscosity of HPC solutions with concentrations of 2% HPC and with the addition of Group I alkali metal ions (chlorides Li, Na, K, Rb, Cr) with a molar concentration of salt in each sample of 0.154 mol/l



Temperature dependence of the size of nanoparticles in the studied solutions





Temperature dependence of the rate of change of the dynamic viscosity of HPC solutions with concentrations of 2% HPC and with the addition of alkali metal ions



PL spectra of HPC solutions at different solution temperatures. Concentration of HPC - 2%; the molar concentration of NaCl salt in the sample is 0.154

Dependence of the temperature of the structural transition in an aqueous solution of HPC on the mass of the added ion.

Conclusions

On the basis of a comprehensive study in a wide temperature range, which includes a structural transition, the influence of ions of alkali metals of the 1st group (chlorides of Li, Na, K, Rb, Cr) was revealed. on the physical properties of liquid smart systems HPC-water.

It is shown that the characteristics of luminescence (spectra and intensity) are sensitive to changes in the structure of the HPC-water-ions solution, which allows determining the temperature of the phase transition and its intensity in these smart systems.

It was established that the temperature of the structural transition in smart HPC-water systems is sensitive both to changes in the concentration of HPC and to the presence of ions.

It is shown that, in the presence of ions, nanoparticles with an order of magnitude larger size are formed above the structural transition in the presence of ions.

The obtained results can be useful in researching similar processes in a wider class of smart materials, in particular - in multi-component ones.

