Research of compositions polymerization of 2-hydroxyethyl methacrylate with polyvinylpyrrolidone in the presence of finely dispersed metal-containing fillers

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The regularities of obtaining of the hydrogel composition materials based on the copolymers 2-hydroxyethylmethacrylate with polyvinylpirrolydone in the presence of different nature finely dispersed metal-containing fillers are investigated. The initiating ability of the bimetal particles in reaction of polymerization is determined and the influence of composition on polymerization kinetics is defined.

Keywords - polyvinylpirrolidone, 2-hydroxyethylmethacrylate, copolymerization, hydrogel, bimetal, metal-containing fillers.

Introduction

Among the significant number of polymer materials the considerable attention is focused to polymer, in particular hydrogel composites with their own electronic conductivity and magnetic sensitivity. The promising application of such materials belongs to electrical and radio engineering, electronic, medical and other industries in order to obtain conductive adhesives, sealants, filling compositions as well as antistatic coatings on metallic and non-metallic surfaces. The object of many studies is the synthesis of materials with particle sizes from micro to nanometers, which thanking the small filler size possess significantly better electrical, magnetic, and other operational properties. Representatives of a new type of such composite materials are the composites based on copolymers of 2-hydroxyethylmethacrylate (HEMA) with polyvinylpyrrolidone (PVP). The fillers of various dispersions, in particular metals and their oxides, in the mentioned composites are used as magnetically sensitive and conductive components, including finely dispersed Fe3O4 colloid. Such copolymers are also effective as nanoreactors for obtaining nanosized metal particles including drug carriers [1, 2]. Establishing regularities in the synthesis–structure–properties chain makes it possible to solve the problems of directed synthesis of filled polymers with given characteristics.

The work purpose is to research the regularities of obtaining filled hydrogel composites based on (co)polymers of HEMA with PVP applying (bi)metal particles and finely dispersed Fe_3O_4 colloid for the polymerization initiation.

Results and discussion

Finely dispersed (bi)metallic particles for research were obtained by precipitation of metals from aqueous solutions of their sulfates with a concentration of 0.05...1 wt.% on iron particles of diameter 0.1...0.8 mm; duration of sedimentation τsad = 5...10 min. Bimetal powders were thoroughly washed and dried. By the X-ray spectroscopic microanalysis of bimetal using the example of Fe – Cu, obtained at a concentration of copper sulfate in a solution of 0.1 wt.%, τ prec. = 10 min on the bimetal surface was revealed , besides Fe (58.4 wt.%) and Cu (17.9 wt. .%) such elements as C (3.3 wt. %) and O (20.4 wt. %) (Fig. 1), which indicates that the particles also contain oxides and carbonates of the mentioned metals. In a longer exposure of iron particles in a 1% aqueous solution of CuSO4 (τ prec. = 24 h), copper almost completely covers their surface (99.2%).

The optimal, from the point of view of obtaining bimetallic particles of sufficient initiating ability is the concentration of copper sulfate in water approximately 0.1...0.5% and the duration of application is 2...3 minutes.

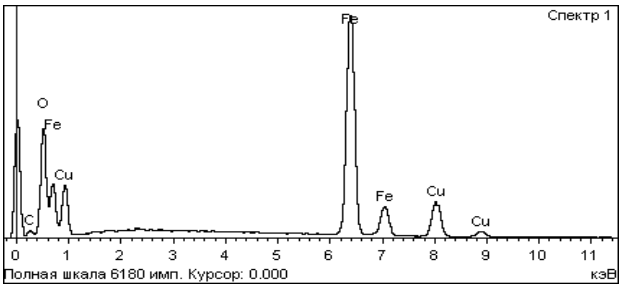

Fig. 1. Spectrum of the Fe-Cu bimetal surface

In order to prevent agglomeration of (bi)metal particles and magnetic colloid they were homogenized in a PVP solution with an ultrasonic homogenizer "Ultrazonic disintegrator UD-20 automatic" for 10 minutes. PVP in this case, being an active reagent in the graft copolymerization reaction performed also the function of a particle stabilizer.

Irregularities of the bimetallic particles surface are the reason that micropotentials arise between the surfaces of different metals in an electrically conductive medium (2% aqueous solution of sodium chloride) which can initiate electrochemical polymerization. In this regard, the kinetics of polymerization of HEMA–PVP compositions in the presence of bimetallic fillers and finely dispersed Fe_3O_4 colloid were investigated. The influence of temperature, concentration, filler nature as well as the polymer:monomer phase ratio on the polymerization kinetics of the studied compositions was studied.

The polymerization velocity is significantly influenced by the nature of the finely dispersed filler. In the case of the studied compositions initiated by benzoyl peroxide, in the presence of finely dispersed Fe_3O_4 colloid at a temperature of 348 K it is possible to achieve the ultimate monomer conversions in the range of 85...90% already after 1 hour. Polymerization of the same compositions without benzoyl peroxide is characterized by a pronounced induction period thus subsequently the polymerization occurs at a rate commensurate with the first case.

The sodium chloride solution creating an electrically conductive environment also has a significant effect on the course of polymerization. During polymerization in its presence, an increase in the polymerization rate is observed and a higher degree of monomer conversion is achieved. If the copper content on the surface of the bimetallic particle exceeded 99, then polymerization did not occur under the experimental conditions. It is obvious that copper inhibits polymerization in this case.

By the studies of the filler nature impact have revealed that the compositions filled with finely dispersed Fe_3O_4 polymerize at a lower speed but with a significantly shorter induction period compared to Fe–Cu bimetal.

Conclusion

The initiating ability of (bi)metal finely dispersed and ferromagnetic colloidal particles in the polymerization of 2-hydroxyethylmethacrylate in the presence of polyvinylpyrrolidone was revealed. The influence of polymerization conditions, nature and amount of ferromagnetic filler on the polymerization rate was determined.

References

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