

Modification of Polymeric Materials with Divinyl Sulphide under the Action of Low-Temperature Plasma

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Abstract

It is demonstrated for the first time that divinyl sulphide is a convenient and efficient monomer for the plasmachemical modification of the surface of various polymeric materials.

Plasmachemical modification of polymers belongs to the most promising methods of obtaining new polymeric and composite materials with improved or even unique set of characteristics [1]. The surface-modified polymers comprise a new class of materials in which the grafted surface compounds mainly determine the chemical properties of a material, while its physical characteristics are mainly determined by the nature and properties of a substrate. This method has substantial advantages over chemical modification of surface because it is ecologically safe, does not require solvents and aggressive reagents, is less energy-consuming and, in addition, allows one to obtain uniform functional layers with a thickness from 100 Å to several micrometers [2].

Divinyl sulphide (DVS), the efficient synthesis methods of which have been developed by us previously [3–5], is a bifunctional monomer acting as a grafting agent (instead of divinyl benzene) in the synthesis of ion-exchange resins with improved performance characteristics [6]. It is also known that DVS is used as a functional monomer rendering a polymer the ability to form complexes with heavy metal ions [4, 7]. The promising character of the use of DVS for plasmachemical modifying of a surface is due to its high reactivity and low boiling point (74 °C/720 mm Hg).

We performed polymerisation of DVS for the first time under the action of low-temperature plasma, both on the surface of commercial polymeric materials (polyethylene tere-

TABLE 1

Characteristics of polymeric materials modified with divinyl sulphide in low-temperature plasma

Material	Concentration, mass %				Amount of grafted DVS, $\mu\text{mol}/\text{cm}^2$	Surface density of mercury after its sorption, $\mu\text{g}/\text{cm}^2$
	C	H	N	S		
Polyethyl terephthalate (film)	62.1	3.94	–	0.57	0.018	0.5 ± 0.03
The same, of PET-E grade (porous)	61.7	4.04	1.23	2.36	0.028	5.6 ± 0.07
Polypropylene (filter)	84.4	11.33	–	0.53	0.017	1.2 ± 0.04
Polyvinyltrimethyl silane (membrane)	56.2	10.25	–	2.93	0.035	0.5 ± 0.03

phthalate, polypropylene, polyvinyltrimethyl silane) and materials based on them (films, filters, membranes, porous materials) (Table 1).

The surface of polymers was treated in a glow low-frequency discharge (frequency: 50 Hz) with DVS vapour pressure of 13.3 Pa. The discharge current strength was 75–100 mA, treatment time was 10 min.

The deposition of a polymeric film of DVS on the surface of polymeric materials was confirmed by means of elemental analysis, in particular by the presence of sulphur in modified materials; its concentration does not change with time. The amount of grafted DVS per unit area of a sample is shown in Table 1. An additional confirmation of the modification of the surface of polymeric materials is the manifestation of sorption activity toward mercury ions due to sulphide sulphur in the surface film.

Modified polymers were placed into a solution of 0.02 M $\text{Hg}(\text{NO}_3)_2$ for 30 min, then washed with water and dried. Mercury content was determined by means of the X-ray spectral procedure with YRA-30 spectrometer (Rh anode, 40 kV, 40 mA, the $\text{Hg}L_\alpha$ analytical line).

So, it was shown for the first time that DVS is a convenient and efficient monomer for plasmochemical modification of the surface of various polymeric materials.

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