The composite specimen method is used to simulate the dynamic mechanical properties of heterogeneous polymeric systems.

One method of improving the properties of polymer materials is to introduce another polymer as a filler or plasticizer. In most cases the resulting system is heterogeneous [1-4]. In practice it is usual to employ mechanical mixtures of two polymers with sharply different glass transition temperatures, so that at room temperature one of the components of the heterogeneous system is in the high-elastic, while the other is in the glassy state. One such material is artificial leather, in which a suitable plastic is often used as a filler. It has also been established that the introduction of a small amount of rubber will improve the mechanical properties of rigid polymer materials [5, 6].

The viscoelastic properties of properties of polymers are usually characterized by specifying the complex dynamic modulus of elasticity $E^*$ [7]:

$$E^* = E_1 + E_i,$$

where $E_1$ is the real part of the complex modulus of elasticity or storage modulus; $E_i$ is the coefficient of the imaginary part or loss modulus.

The internal friction in polymers is generally characterized by the loss tangent $\tan \delta$ [7]:

$$\tan \delta = \frac{E_i}{E_1}.$$ 

We have investigated the temperature dependence of the dynamic mechanical characteristics ($E_1$ and $\tan \delta$) for mixtures of two polymers with sharply different glass–transition temperatures and have attempted to develop a method of predicting the variation of the dynamic mechanical properties of a two-component heterogeneous polymer system on the basis of a knowledge of the properties of each component.

The measurements were made on instruments designed at the Problem Laboratory of Polymer Physics [8]. The temperature dependence of $E_1$ and $\tan \delta$ is shown in Fig. 1 for a composition consisting of 83 wt.% SKI-3 rubber and 16 wt.% Marbon 800A high-styrene resin (the composition was vulcanized with a small amount of sulfur).* As may be seen from the figure, there are two regions of relaxation, corresponding to inflections on curve 1 and loss maxima on curve 2. The location of the low-temperature region (at -70°C)

*The 1% represents the other ingredients of the composition.
Fig. 1. Temperature dependence of $E_1$ (1) and tan $\delta$ (2) for the composition SKI-3 + Marbon 800A.

Fig. 2. Temperature dependence of $E_1$ (1.2) and tan $\delta$ (1', 2') for PS (1.1') and a mixture of PS and SKS-30 rubber (2.2').

Fig. 3. Temperature dependence of $E_1$ and tan $\delta$ for a combined system of parallel- (a) and series-connected (b) specimens of SKN-40 rubber and polyvinyl chloride: 1, 2, 5, 7) $E_1$; 3, 4, 6, 8) tan $\delta$; 1,3) experimental data; 2, 4) data calculated from (4)-(6) at $V = 0.5$ and a frequency of $5 \times 10^{-8}$ Hz; 5, 8) $E_1$ and tan $\delta$ for PVC; 6, 7) the same for SKN-40.

The temperature dependence of $E_1$ is noteworthy. In the low-temperature relaxation region there is a sharp change in the value of $E_1$ with temperature, whereas in the high-temperature relaxation region the fall of the modulus is much less pronounced. This is because the stiffness of the composition is chiefly determined by the mobility of the SKI-3 rubber molecules (because of the predominance of the latter) and is largely lost when this component goes over into the high-elastic physical state.

The opposite case is reflected in Fig. 2, which shows the temperature dependence of $E_1$ and tan $\delta$ for pure polystyrene (PS) and PS mixed with 15 wt. % SKS-30 rubber. In this case there are likewise two regions of relaxation associated with the glass transition processes of the components. The low-temperature region corresponding to a loss maximum at $-60^\circ$C is expressed only as a sharp increase in mechanical losses at high temperatures, the process beginning at a lower temperature (of the order of $+65^\circ$C) in the case of the composition containing rubber, i.e., the effect to some extent resembles plasticization.

Here, the variation of the modulus with temperature is quite different. In the region of $-60^\circ$C there is only a slight decrease in the value of the modulus,