PROPERTIES OF RUBBER GRANULATE-POLYURETHANE COMPOSITES OBTAINED FROM WASTE MATERIALS

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Introduction

The solution of the problem of plastics and rubber waste utilization depends on the advancement in the field of utilization methods and management, application of recycling rules and low regulations connected with waste.
One of the possibilities of rubber waste management is to break it up and use the obtained granulate, fine rubber, or rubber dust as valuable materials. Application of granulate or fine rubber, products obtained from the waste rubber, mixed with a small amount of elastomers is studied Due to problems with rubber waste management, the studies of properties and influence of isocyanate structure on polyurethane-rubber waste composites, obtained from waste car tyres granulate and fine rubber, were conducted [1-5].
One of the possible ways to convert used products made of polyurethane foam is their chemical recycling in the process of glycolysis. As a result of this process different polyols are obtained which can be reused for the production of polyurethane products. The aim of the investigation was to determine the properties of the polyurethane-rubber composites obtained from used products. In this study the products obtained from chemical recycling of semi-rigid integral polyurethane foam in the form of glue and car tyres granulate received from material recycling were used.

Experimental

Polyols, Recypol®201 and Recypol®601, which are polyetheropolyols obtained in the glycolysis process from used semi-rigid polyurethane foam obtained by the method developed by the German company RAMPF Ecosystems GmbH and rubber granules of 1.5 mm to 2 mm were used to receive polyurethane-rubber composites.

Strength of the obtained composites was performed according to Polish standards. The dynamic thermo-mechanical analysis in the DMA Q800 apparatus of TA Instruments were also performed. Measurements were carried out at the temperature range from 123 K to 323 K at a heating rate equal to 2 K/min with the bending frequency range from 1 to 150 Hz. The analysis of the DMTA spectra allowed us to determine the glass transition temperature T_g and the course of the relaxation processes in the composites. The analysis of the changes in the storage module E' and loss module E'' as a function of temperature enabled the calculation of the activation energy for relaxation processes of various polyurethane glues and polyurethane-rubber composites.

Results and Discussion

The influence of the urethane glue compositions on the hardness and relaxation properties of the obtained stable composites was studied.
The hardness of used rubber before granulation was 60 ^{0} Shore A. The influence of the amount of polyurethane glue and amount of isocyanate diphenylmethane 4,4'-diisocyanate (MDI) on composite hardness was observed (Fig. 1). One can notice that for the polyurethane glue prepared from polyols Recypol®201 (30 %) and Recypol®601 (70 %) the hardness for the polyurethane was higher than the hardness for composites prepared with the use of this polyurethane glue. The hardness of the polyurethane prepared from polyols Recypol®201 (50 %) and Recypol®601 (50 %) was similar to the hardness for composites prepared with the use of this polyurethane glue. In contrast the hardness for the polyurethane prepared from polyols Recypol®201 (70 %) and Recypol®601 (30 %) was lower than that for composites prepared with the use of polyurethane glue.

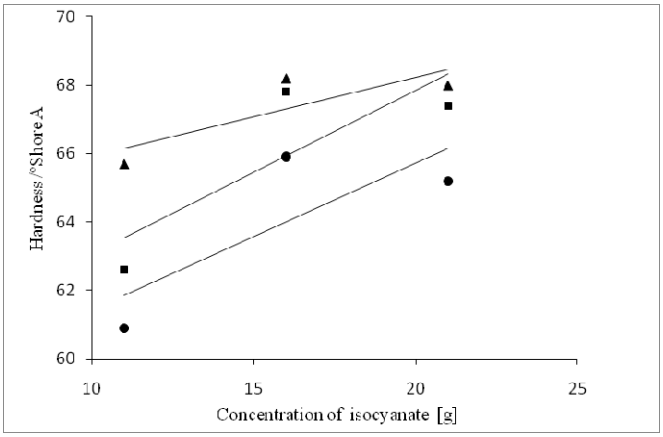

Fig.1 Dependence of hardness on isocyanate content in the composites obtained
from polyurethane glue/rubber; ●5/95; ■7,5/92,5; ▲10/90 under pressure $2 \cdot 10^6$Pa

The course of the curve of storage module *E'* as a function of temperature for low temperatures is typical for polymers and characterizes the glass state. The fall in the value of *E'* is related to the changes of the polymer properties and to the transition of material from the glass to the flexible state (viscoelasticity) and can be caused by the changes occurring at the phase boundary for the composite materials. In the studied temperature range (123 K to 323 K) it was observed that values of *E'* for the same frequency varies for different polyurethane glues as well as for polyurethane-waste rubber composites. The values of *E'* for polyurethane-waste rubber composites are higher than those for polyurethane glues used to receive them. Lower values of *E'* module for polyurethane glues in comparison to the value of *E'* module for polyurethane-rubber composites were observed.

Conclusions

Stable and flexible composites from rubber granulate and polyurethane glues were obtained from polyols prepared from recycled semi-rigid integral polyurethane foams and MDI.
The influence of the amount of polyurethane glue and amount of isocyanate MDI on the mechanical and relaxation properties of composites was noticed. This observation points to the effect of microstructure of composites on these properties and the interfacial tension between rubber granules and polyurethane

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