COMPOSITES BASED ON SECONDARY POLYETHYLENE AND GEORGIAN MINERALS

Lana Shamanauri and Jimsher Aneli
R.Dvali Institute of Machine Mechanics, 10 Mindeli Str. Tbilisi 0186 Georgia, e-mail: jimaneli@yahoo.com

Abstract: The polymer composites on the basis of secondary polyethylene and the minerals spread in Georgia (andesite from Bakuriani, quartz sand from Sachkhere and slag from Okami) have been obtained. There are studied some physical-mechanical properties, thermal stability and materials hydrophobycity. It is shown that the ultimate strength and thermal stability of the composites extremely depend on the type and concentration of the filler. For composites containing binary filler (quartz sand + slag) discovered the sinergistic effect- anomaly increasing of the ultimate strength at definite ratio of the fillers.

1. Introduction

Environment ecological protection and utilization of the industrial wastes present today very important and actual problems. From the scientific- technical literature it is known that if the development of the composites based on secondary thermoplast materials, in which the different dispersive or natural and artificial fiber fillers are used, about 40 % of the primary ores can be spared. In the secondary polymer composites the industrial technological wastes as trimming, injection molding heads technical tare, films, bottles and so on are used. The content of such wastes was varied in the range 10 - 60 %.

Polyethylene now is one of more spread polymer, which is due to many positive exploitation properties and low cost [1, 2]. The high pressure polyethylene industrial wastes as binder are used in our work.

2. Experimental

2.1 Research objects and methods of obtaining

There were used the fine dispersive powders, obtained in result of grinding of different polyethylene bags of domestic destination. Most of them are made from polyethylene of high pressure (with low density). Three types of minerals Bakuriani andesite, Sachkhere quartz sand and Okami slag were used as composite fillers with wide range concentrations.

Below the short characteristics of these fillers are presented.

andesite (word basis -American mountains Ands) volcanic origination dark red color dense, but sometimes is porous material. This mineral is wide spread material in the AdJara- Trialeti mountain (Borjomi-Bakuriani, Tsikhisjvari) kazbegi region (mkinvartsvery, Kabarjina), in the sources of the rivers Liakhvi, Ksani, and Aragvi, on the Javakheti plateau. Andesite is used as a building and acid proof material;

- Quartz sand from Sachkhere *includes the quartz particles, content of silicon oxide near70-85% and rest are iron, calcium and magnesium oxides. Besides of the sand includes 5% clay and dust particles.*
- slam from Okami *is red color micro-porous volcanic generated mineral with high specific surface. In Georgia this mineral is used as warm-isolated material . The slam is belong to basalt type porous variety. It is the glass with alumo-silicate content (75-80%). 20% of this material is crystallic. Density 2630 kg/m^3.*

At the initial stage the mixing of composite ingredients in the propeller mill during 2-3 min.

In result of mixing of the polymers and different fillers the homogeneous powder was obtained, which after preliminary drying at 50-70^{o}C underwent to the pressing in the standard press-forms (cylindrical and rectangular). The samples were obtained after pressing at 8-10 MPa and temperature 140-150^{o}C during 10-15 min.

2.2. Methods of samples testing

The samples were tested on the strengthening at compression. Mechanical parameters were defined on the Germany device of type Dinstant. The water absorption was defined separately. The temperature stability was defined on the apparatus of Vica.

3. Results and discussion

First of all it was necessary the determination of dependence of material properties on the type and concentration of fillers. With this aim on the basis of polyethylene we obtained the composites, in the content of which the mineral powders with concentrations 20-60wt% (20,30,40, 50 and 60) were included.

On the Fig.1 The dependence of composite mechanical strengthening (at compression) on the filler concentration is presented. From this Figure one can see that this dependence for all samples has an extreme character, on the curves the maximums are appeared. This result is in full agree with well known dependence - the left side of these curves corresponds to mechanical enhances because of formation the contacts between macromolecules and filler particle surfaces, but after definite concentration in result of formation of filler particles associates (at this moment not all particles wetted by macromolecules), which is equivalent to formation of the definite structural defects, the mechanical strengthening of composites decreases step by step. This process enhances with future increasing of the filler concentrations. The difference between curves is described by difference of filler types. This difference is expressed in the character of particles surface profile (partially surface smoothness). The particles with deep irregularities contribute to penetration of the polymer segments to the micro-empties of filler particles and formation of engagements. In this way physical bonds are formed (formation of Van-der-Waals bonds), which lead to increasing of mechanical strengthening of the composite. Besides of here it is possibility the formation of chemical bonds between active chemical groups on the filler surface and macromolecules, which will further strengthen the composite. The character of the noted dependence appears in the thermal stability properties - at near same concentrations thermal stability receives the stable significances, which corresponds to limit of this parameter (Fig.2).

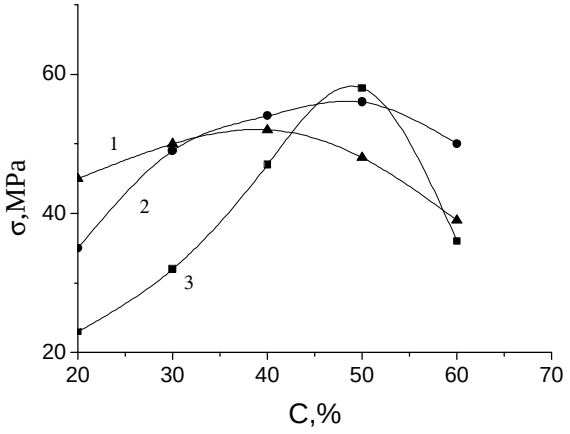

Fig.1. Dependence of the composite ultimate strength (at compression) of the PE composites containing quartz sand (1), slam(2) and andesite (3) on the filler concentration

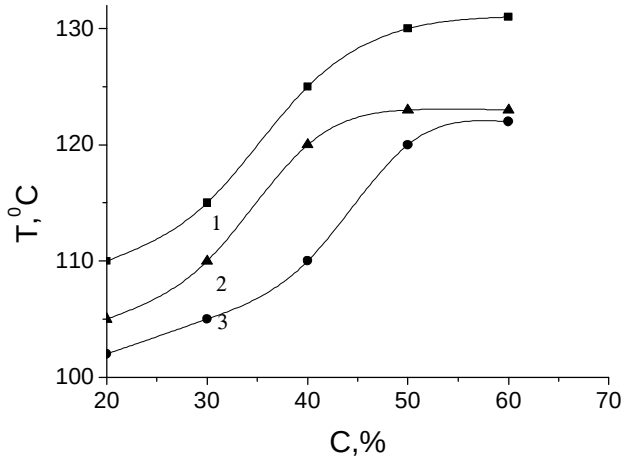

Fig.2. Dependence of the composite softening (by Vica method) of the PE composites containing quartz sand (1), slam(2) and andesite (3) on the filler concentration

It is known that in some cases it is possible to increase the physical properties of composites by use of binary fillers [3]. With this aim we prepared the composites based on PE and binary fillers quartz sand and slam, concentrations of which was varied in two groups of sum concentrations: 40wt% and 50wt%. In accordance with the experimental data on determination of the dependence of ultimate strengthening of composites on the different proportion of the fillers in them these curves are characterized with maximums.

On the Fig.3 the maximum of ultimate strength appears for composites containing the fillers slam and quartz sand with proportion 30/70 (curve 1), when the sum of the fillers is 50wt%. Analogical maximum has the curve 2 of the same dependence at proportion of the same fillers 40/60, when the sum of the fillers is 40wt%. The maximums on the curves are corresponded to s. c. synergistic effect - non-additive improving of the material properties at definite proportion of ingredients in the binary filler [4].

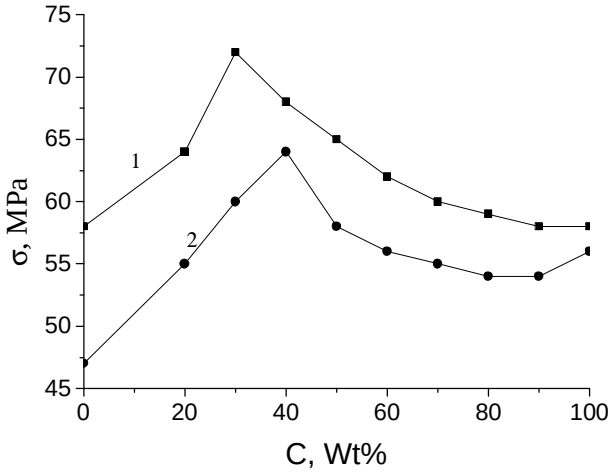

Fig.3. Dependence of the composite ultimate strength (at compression) of the PE composites with binary filler (quartz sand + slam) at the filler sum concentration 50wt % (1) and 40 wt% (2). On the x axis - the concentration of slam in binary filler

Comparison of numerical data of obtained dependences for composites containing binary fillers (Fig.3) and composites with one filler (Fig.1) shows that by combination of the fillers it is possible to enhance the mechanical properties of the composites. It must be noted that the experiments on investigation of hydrophobic properties of the composites show that water absorption by composites is rather low (no more that 1.5%). This fact show that the microstructure of the composites contains a rather low amount of structural defects (partially empties, cracks, etc).

Conclusions

1. ***On the basis of industrial and domestic wastes there are obtained and studied polymer composites containing fine dispersed andesite, slam and quartz sand.***
2. ***Experimentally is established that the physical-mechanical, thermal and hydrophobic properties are essentially depend on the type and concentration of the fillers.***
3. ***In case of the composites containing binary fillers it is fond the optimal proportion of the fillers in the blend, which ensure some physical properties better than for composites containing one filler from binary blend.***
4. ***Water absorption of all investigated by us composites is not more than 1.5%.***

References

[1] Achilias D.S., Roupakias C., Megalokonomos P., Lappas A.: Journal of Hazardous Materials,2007, 149, 536.
[2] Jassim A.K.: Procedia Manufacturing, 2017, 8, 635.
[3] Asare E., Basir A., Tu W., Porwal H., Zhang H., Liu Y.: Nanocomposites, 2016, 2, 58.
[4] Pedrazzoli D., Pegoretti A., Kalaitzidou K.: J.Appl.Pol.Sci., 2015, 132, 4168.