Achievements in Mechanical and Materials Engineering

COMMENT Worldwide Congress on Materials and Manufacturing Engineering and Technology
16th - 19th May 2005 Gliwice-Wisła, Poland

COMMITTEE OF MATERIALS SCIENCE OF THE POLISH ACADEMY OF SCIENCES, KATOWICE, POLAND
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13th INTERNATIONAL SCIENTIFIC CONFERENCE ON ACHIEVEMENTS IN MECHANICAL AND MATERIALS ENGINEERING

Investigations of the influence of filler on the properties of chosen polymer blends with compatibilizer addition

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Abstract: Within the work some results of chosen properties of PP and PA and PP/PA blends with different percentage composition with the addition of polyvinylpyrrolidone (PVP) have been presented. The investigations for the influence of the fillers on the properties of prepared blends have also been conducted. As a filler a titanium white (TiO_2) have been used.

Keywords: Blends, Mechanical properties, Compatibilizer, Filler

1. INTRODUCTION

The polymer blends take an important part in the development of the technical polymer use. During the last twenty years it is the polymer blends that have been very popular as a new group of polymer materials with interesting and sometimes very specific properties [1, 2, 3]. The reason for polymer blends manufacturing is the will to eliminate or to diminish the drawbacks that characterize the polymers and also desire to drop the price of the expensive polymers with specific properties by mixing them with the cheaper ones, without significant deterioration in these precious properties. Further purpose is to match some very important properties of two polymers along with the diminishing their individual disadvantages. Moreover, manufacturing of the blends out of the polymers being already known is generally much faster than designing and manufacturing of the new polymers. Implementation of the production of blends on a large industrial scale is also cheaper since it bases only on the processes of mixing and, other than the synthesis of new polymers, it requires much smaller investments [4, 5].

Mixing polymers one can modify certain properties, mainly physical, e.g. density, hardness, impact resistance, tensile strength etc.

The purpose of the work was to test certain physical properties of the blends of PA/PP with different composition with the chosen compatibilizer and filler.

Commonly applied method of the physical modification of the polyamides is filling them with the powder mineral fillers (e.g. talc, graphite, molybdenum disulphide, barium sulphate (VI), titanium white) as well as cut and long glass fibre. More stabile properties could be found for polymer composites, e.g.: lower water absorptivity, lower coefficient of thermal expansion, increased temperature of the resistance to deformation under the load, more stabile dimensions of the formed components, higher modulus of elasticity and higher impact

strength [1, 2]. The properties of the polyamides can be also modified by adding other polymers, mostly PP, PE, POM, epoxide resin and PET and preparing appropriate blends with suitable compatibilizers.

2. MATERIALS AND INVESTIGATION METHODOLOGY

The following materials have been used for the investigation purposes:

- polyamide 6 (PA6) with the commercial name Tarnamid T-27 manufactured by Tarnowskie Zakłady Azotowe (Poland), used for manufacturing, by means of the method of injection, of highly durable materials including the thin wall ones, fishing lines, fibres and modified granulates. Its drawback is quite high sorption of the water from the environment.
- polypropylene (PP) with the commercial name Malen PJ-400 manufactured by Petrochemia Płock S.A. (Poland). The basic application of this plastic is production of the injected goods for technical use and the goods of common use e.g. household equipment, garden furniture, disposable syringes, details for the automotive industry etc. It is characterized with lower resistance than PA but also with lower water absorptivity. It is also a cheap plastic.
- polyvinylpyrrolidone (PVP) [6] with low molecular mass (12±2 k) – the polymer with the amorphous structure, having high diffusion/sorption ability compared to the polymers with diagonal group [-NH-]. It is characterized by the good solubility in water and alcohols. Its softening point appears within the limits of 90 ºC ÷ 110 ºC and depends on the air humidity. PVP decreases internal stresses of copolymers and the shrinkage after polymerisation; its drawback is high absorptivity of water from the air.
- Titanium oxide (TiO_2).- manufactured out of titanium ores by treating with the sulphuric acid and thermal decomposition of the separated titanium acid.

Samples for the investigations have been prepared by means of the method of injection on a computer aided KM 65-160 C1 injection moulding machine out of the above mentioned materials with the following percentage composition:

1. Blend of PA / PP / PVP (PP 90% / [PA 90% / PVP 10%] 10%, PP 80% / [PA 90% / PVP 10%] 20%, PP 70% / [PA 90% / PVP 10%] 30%).
2. Blend of PA / PP / PVP + 1% (TiO_2) (PP 90% / [PA 98% / PVP 2%] 10%, PP 90% / [PA 90% / PVP 10%] 10%, PP 70 / [PA 98% / PVP 2%] 30%, PP 70% / [PA 90% / PVP 10%] 30%)

To mix the ingredients, the twin-screw THEYSOHN TSK 75-N extruder has been used.

The investigations of the chosen properties of the obtained polymer materials have been conducted, i.e. the hardness with the ball hardness tester, impact resistance with Charpy impact tester, tensile strength with the tensile strength tester of Zwick type, flow rate index with the DYNISCO-KAYENESS plastometer, and the softening temperature point according to Vicat method with the HAAKE N8 machine, according to the present standards.

3. RESULTS OF INVESTIGATION AND DISCUSSION

The results of the investigations on the mechanical properties while tension for PA/PP blends with the same composition with chosen fillers and compatibilizers are shown in the Fig. 1. In the Fig. 2a one can observe that increase in the amount of PVP in the composites of blends causes the increase in MFR. The results for water absorptivity tests for the blends

of PA/PP with different composition using the same fillers and compatibilizers have been presented in the Fig. 2b.

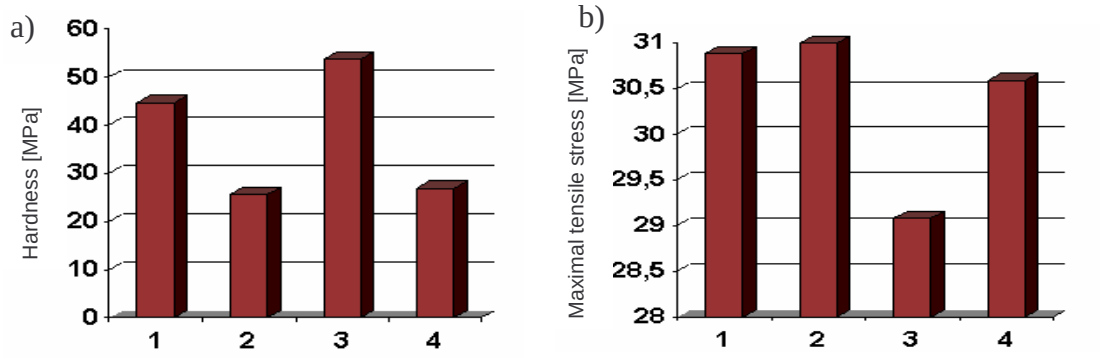

Figure 1 a) The results of hardness tests:1. PP 90% / [PA 98% / PVP 2%] 10% + (TiO_2) 1%, 2. PP 90% / [PA 90% / PVP 10%] 10% + (TiO_2) 1%, 3. PP 70% / [PA 98% / PVP 2%] 30% + (TiO_2) 1%, 4. PP 70% / [PA 90% / PVP 10%] 30% + (TiO_2) 1% b) Maximal tensile stress: 1. PP 90% / [PA 98% / PVP 2%] 10% + (TiO_2) 1%, 2. PP 90% / [PA 90% / PVP 10%] 10% + (TiO_2) 1%, 3. PP 70% / [PA 98% / PVP 2%] 30% + (TiO_2) 1%, 4. PP 70% / [PA90% / PVP 10%] 30% + (TiO_2) 1%

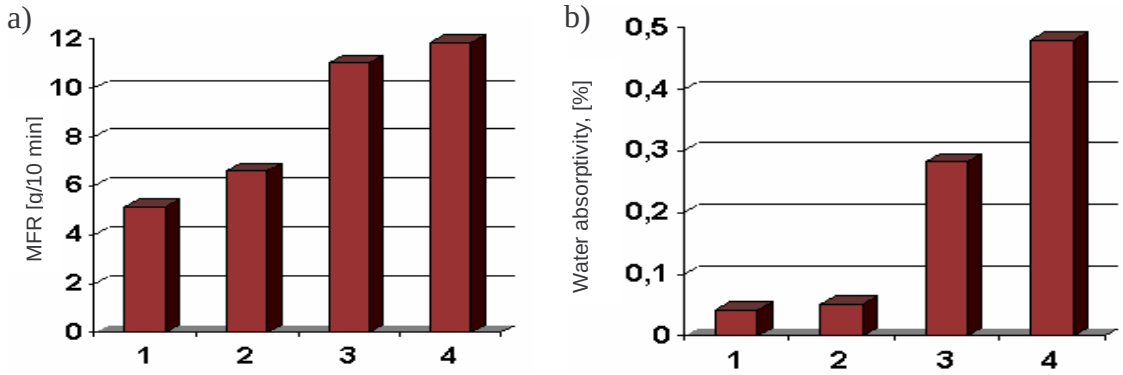

Figure 2. a) MFR tests results: 1. PP 90% / [PA 98% / PVP 2%] PA 10% + (TiO_2) 1%, 2. PP 90% / [PA 90% / PVP 10%] PA 10% + (TiO_2) 1%, 3. PP 70% / [PA 98% / PVP 2%] PA 30% + (TiO_2) 1%, 4. PP 70% / [PA 90% / PVP 10%] PA 30% + (TiO_2) 1%; b) The results of water absorptivity tests: 1. PP 90% / [PA 98% /PVP 2%] PA 10% + (TiO_2) 1%, 2. PP 90% / [PA 90% / PVP 10%] PA 10% + (TiO_2) 1%, 3. PP 70% / [PA 98% / PVP 2%] PA 30% + (TiO_2) %, 4. PP 70% /[PA 98% / PVP 2%]PA 30% + (TiO_2) 1%

The polymer blends and composites are nowadays the resources for the new construction materials. The applied polymers are partly immiscible and therefore, to obtain the blend with good mechanical properties, it was necessary to introduce the compatibilizer. The compatibilizer is present at the border of two phases of the both polymers. In the present case it has been a polyvinylpyrrolidone with very high hygroscopicity and low molecular mass.

Despite the possibility of the mechanical mixing the components with known properties, it is impossible to predict all the properties of the polymer blend.

In case of mechanical properties, while increasing the amount of polyamide in the compatibilized blend the tensile strength increases. For the investigations of water absorptivity the significant increase of the value (while increasing the amount of the PA) is observed. For the investigations of impact resistance the significant drop in the value (while increasing the amount of polyamide) is observed.

The investigations highlight the possibilities to manufacture the blends of polypropylene and highly-hydrophilic polymers such as polyvinylpyrrolidone of low molecular mass used for the investigations and also its blends with polyamide 6. It has been found on the basis of the results that mixing PP with the previously prepared PA6/PVP blend causes obtaining the polymer material with higher elasticity and with certain stability of the sorption properties.

The application of the filler significantly influences the change in the mechanical, thermal and processing properties of the investigated blends.

4. REFERENCES

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