STRUCTURAL, THERMAL AND MECHANICAL CHARACTERISTIC OF THE POLYAMIDE 6/MODIFIED HALLOYSITE COMPOSITES

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Introduction:

The reinforcement of polymers thanks to the addition of nanofillers such as clay minerals or carbon nanotubes has attracted much attention in polymer engineering since decades [1-5]. Polyamide 6 (PA6) is an important semicrystalline engineering plastic which finds its application in automobiles, electrical appliances, construction materials and so on. However, the drawbacks such as limited mechanical strength and dimensional stability restrict its applications. Halloysite is a type of natural tabular nanoclay and has been recognized as an effective nanosized reinforcement of polymers for better mechanical and thermal properties [6-8]. The objective of this work is to investigate the influence of the surface treatment of halloysite by using gelatin on the mechanical and thermal properties of PA6 composites.

Experimental:

The first modification stage of the treatment of the mineral with ultrasound (HU) was performed for the purpose of the generation of structural defects on the crystallographic surface. The choice of organic compound used in modification was made taking the possibility of an active interaction with PA6 matrix into consideration. The effect of modification of halloysite by using gelatin (HUG) was measured by electron microscopy (SEM and SEM-EDS) analysis. As can be observed in the EDS-spectrum for the HUG filler, the peak from carbon is present. It indicates the presence of the organic compound on the surface of mineral. The composites based on PA6 containing 3 or 5 wt. % modified halloysite were prepared by using Brabender mixer. Mechanical and thermal properties have been investigated by tensile, flexural and impact strength testing and DSC and TG analysis.

Results:

Table 1. Mechanical properties of PA6/halloysite composites

Names of composites	Type of modifier / % contain	Tensile strength [MPa]	Young's Modulus [MPa]	Tensile strain [%]	Flexural strength [MPa]	Flexural modulus [MPa]	Charpy Impact [kJ/m^2]
PA6	-	57 ± 4,5	1284 ± 12	147 ± 2,0	61 ± 6,1	3030 ± 10	7,5 ± 2,1
1	HU/3	43 ± 4,0	1485 ± 14	76 ± 1,2	63 ± 5,8	3129 ± 13	6,5 ± 2,5
2	HU/5	42 ± 3,5	1442 ± 10	69 ± 2,4	56 ± 7,0	3126 ± 11	6,3 ± 2,0
3	HUG/3	73 ± 3,9	1592 ± 11	96 ± 1,9	74 ± 5,4	3190 ± 9,0	6,5 ± 1,0
4	HUG/5	75 ± 4,2	1517 ± 16	74 ± 2,3	68 ± 6,2	3146 ± 12	5,7 ± 1,5

Table 2. Thermal properties of PA6/halloysite composites, determined by DSC method

Names of composites	Type of modifier / % contain	DSC					
		ΔH_m [J/g]	T_m [ºC]	ΔH_c [J/g]	T_{cryst} [ºC]	X_c [%]	T_g [ºC]
PA6	-	57,9	222,4	65,1	186,2	30,7	54
1	HU/3	62,5	221,9	66,0	186,9	33	53
3	HUG/3	44,6	221,9	61,9	185,0	23,6	49
4	HUG/5	42,5	221,8	60,2	185,4	22,5	50

Conclusions:

Preparation and application of halloysite based modifiers in the filling of polyamide 6 have been presented. The chosen modification method was found to be effective in obtaining active fillers. Structural analysis, especially SEM/EDS and PCS methods confirmed an additional layer on the halloysite surface of an organic layer derived from the applied modifying compound. Our investigations reveal that the addition of HU favours the formation of the γ-modification for PA6. The determined mechanical properties indicate an advantageous influence of the filler on increasing the resistance of PA6.

References

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