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MATERIAL CHOOSING FOR POLYMER PARTS PRODUCTION BY MEANS OF MULTICOMPONENT MOLDING METHOD

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Summary. Main factors affecting the quality of the finished polymer product, produced by multicomponent molding are analyzed in the article.

Keywords: multicomponent molding, viscosity, shrinkage, polymer**.**

INTRODUCTION

Waste of polymeric materials, on the one hand, is an environmental contamination source, and on the other hand – cheap raw material for production of application wide range products. The most expedient from the ecology and energy conservation side is a polymeric waste recycling, that is the main environmental problem nowadays. Therefore creation of conditions for expansion of a raw-material base, reduction of raw material, fuel and energy resources losses, and also decrease of environmental contamination level are the major principles of industrial policy in our country [1].

Recycling method is most widespread, however on a way of its realization there are serious difficulties. Even if a polymeric waste is carefully separated from other garbage, they can't be overworked in polymeric recycling product with satisfactory properties because of a singularity inherent in polymers – inability to mix up with one another or, speaking strictly scientifically, their thermodynamic incompatibility. At mixing of polymers even the close chemical nature (for example, polyethylene and polypropylene) the two-phase disperse systems which properties are much worse, than properties of initial components more often are formed. Therefore before processing of a polymeric waste, for example packages, by fusion in granules, suitable for manufacture by molding of new polymeric products, the most careful sorting of a waste according to a chemical compound is necessary [15].

Molding methods were widely adopted in processes of new qualitative products obtaining from secondary polymeric materials. To such methods we can refer extrusion, co-extrusion, multicomponent molding etc. [2].

OBJECTS AND PROBLEMS

The choice of materials admissible combination for manufacture of new qualitative polymeric details by means of multicomponent molding method with usage of secondary polymeric materials plays a main role for the environmental contamination level reducing, and also for resource-saving and energy conservation. It is necessary to take the careful analysis for determination of their compatibility, chemical stability and wear resistance, and also maintenance possibility in environmental conditions and correspondences to other special requirements. Viscosity of melts and value of shrinkage should be relatives [11,17,20]. Various combinations of materials lead to wide range of adhesion strength of a basic material with put on it other polymer. It is possible to achieve adhesion from zero level to durability of a chemical bond when materials interact at molecular level and create heavy-duty adhesion which is characterized by long life in the conditions of aggressive chemical environment. As multicomponent molding includes adhesion of various materials in one complex product durability of materials adhesion plays a crucial role. To factors which influences on durability of adhesion it is possible to put compatibility, temperature of technological process, the area of contact surfaces, a texture, sequence of injections performance and construction of details concern at their mechanical adhesion [14].

Co-injection or Sandwich Molding gives the chance to reduce production costs owing to usage of cheaper secondary materials everywhere where there is no necessity for exclusive usage of high-quality material, for example, as capacity filler [7]. Thus, as base material it is possible to use secondary polymeric raw materials because in products made according to sandwich-molding technology this material is not visible and expensive materials are used only for creation of a thin decorative blanket.

By sandwich-molding technology it is possible to produce products of the difficult form with application wide range – from electrical and consumer goods to various special industries (table 1) [5,9].

Table 1. **Examples of the products made by sandwich-molding technology**

Automobile industry	Other branches
Lock casing	Tooth-brushes
Reflectors for headlights	Tool handles
Ventilating grid	Toys
Connectors for safety pillows	Buttons of various devices
Door gaskets	Accessories
The air duct dampfer	Garden furniture
Colorfull scatterers of back stop signal lights	Remote control units cases for TV sets

Sandwich molding allows using a wide range of polymeric materials. Though the majority of them are thermoplastics, there are some promising improvements thanks to which thermosetting materials are used with the thermoplastic. As two materials here are used, a property of melts and their compatibility has a great value. During material selection process the most important criteria are: a difference in viscosity and adhesion between surface and basic materials. As the basic material should penetrate in surface it is desirable that viscosity of the surface material was lower, than at basic. Usage of a

material with low viscosity as the basic leads to that the front of this material melt flow is moved too quickly concerning surface that as a result is badly reflected in quality of a product surface. An experimental research of sandwich molding has been connected to check influence of viscosities ratio of the surface and basic materials on their space distribution in a product [3,12,13].

As in a finished product both materials are allocated by layers, for achievement of optimum characteristics of mold their reliable adhesion is necessary. In table 2 the basic information for a considerable number of various materials combinations is resulted [4,18,19]. It is necessary to mark that it can be used only for acquaintance. Real functional characteristics should be defined by finished product field of application as the final result depends on parameters of molding process. One more property of a material which should be considered is shrinkage. There is a thumb rule which demands that used materials had identical shrinkage at molding. It will allow to reduce pressure in adjoining layers [5,6,16].

Table 2. **Polymer materials adhesion**

	ABS	ASA	CA	PA 6	PA 6.6	PA-Blend	PBTP	PC	PC/ABS	PC/PBT	PC/PET	PE	PETP	PMMA	POM	PP	PPO	PS	SAN	TPE/TPU
ABS	△	▲	▲	▲	▲		▲	▲	▲	▲	▲	□	▲	▲	■		■		□	□
ASA	▲	△	▲		▲		▲	▲	▲	▲	▲	■	▲	▲	■	■	■	■	▲	□
CA	▲	▲	△				▲					■			■	■	■			
PA 6	▲			△	△	▲	▲	□	▲	▲	▲	□			■	□	■	■		□
PA 6.6	▲	▲		△	△	▲	□		▲	▲	▲	□			■	□	■	■		□
PA-Blend				▲	▲	△									□	□	■			□
PBTP	▲	▲	▲	▲	□		△	▲	▲	▲	▲	□	▲	□	□	□		□	▲	□
PC	▲	▲		▲			▲	△	▲	▲	▲	■	▲		□	■		■	▲	□
PC/ABS	▲	▲		▲	▲		▲	▲	△	▲		■			□	■		■		□
PC/PBN	▲	▲		▲	▲		▲	▲	▲	△	▲	■	▲	▲	□	■		■		□
PC/PET	▲	▲		▲	▲		▲	▲	▲	▲	△	■	▲	▲	□	■		■		□
PE	□	■	■	□	□		□					△				▲			□	▲
PETP	▲	▲					▲	▲		▲	▲	■	△							□
PMMA	▲	▲					□			▲	▲	■		△		■	■	■	▲	□
POM	□	■	■	■	■	□	□	□	□	□	□	■			△					□
PP		■	■	□	□	□	□	■	■	■	▲			■		△	□			
PPO	■	■	■	■	■	■								■		□	△			□
PS	■	■		■	■		□	■	■	■	■			■			▲	△		□
SAN	□	▲	▲				▲	▲	□	□	□	□		▲			■	□	△	▲
TPE/TPU	□	□		□	□	□	□	□	□	□	□	▲	□	□	□	□	□	□	▲	△

Designation	Ahhesion
■	no adhesion
□	limited
▲	normal
△	high

At sandwich molding following material combinations for a sheath and the core are possible:

- solid sheath – foam core,
- solid sheath – solid core

For walls in the thickness more than 4 mm are used the solid material in a combination to a core made from a foam secondary polymer (figure 1). It allows to avoid appearance of sections with shells that reduces internal pressure in a mold product. The details made on this method unite in themselves favorable structural

properties of details from the foam polymeric material with a low roughness of solid details surface [8].

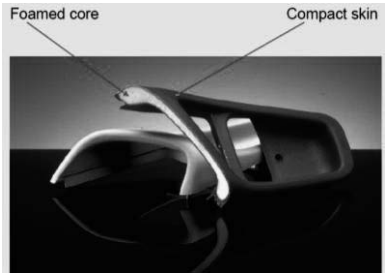

Fig. 1. Solid material in a combination to a core made from a foam secondary polymer

For walls in the thickness less than 4 mm a sheath and core materials are solid. In this case specific properties of a product are reached at the expense of raw materials correct selection for sheath and core (figure 2).

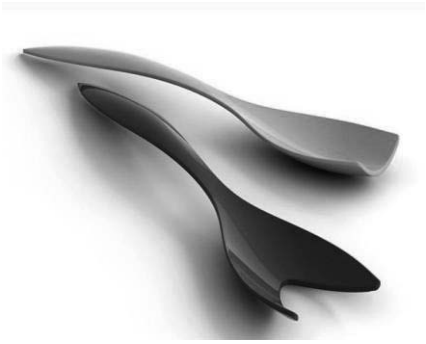

Fig. 2. Solid material in a combination to a solid core from a secondary polymer

High quality of a detail surface at low durability of an external material can be added with high strengthening properties of a core material [10].

For saving of resources as a core material it is necessary to use products of secondary plastic processing. In a combination to a sheath from a raw material such combination allows to receive products with high quality of a surface. Such approach has received the greatest propagation in the autoindustry where as a core material for brand new bumpers the overage processed plastic details of the cars are used. Insignificant impairment of polymeric material properties after secondary processing doesn't affect the general physical and mechanical properties of a completed product.

CONCLUSIONS

One of the main factors affecting the quality of the finished product, produced by multicomponent molding is the compatibility of polymers and the uniformity of the melt (thickness variation) in the mold. Compatibility is determined by the chemical nature of the material and can be improved through the introduction of additives or adhesives.

The analysis of materials for qualitative plastic parts production by means of multicomponent molding using raw materials as the core it is necessary to pay attention to following five pacing factors:

1. Adhesion of materials.
2. Polymers thickness.
3. Shrinkage of these materials.
4. Thermal extensions for both materials.
5. Polymer melts viscosity.

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ВЫБОР МАТЕРИАЛОВ ДЛЯ ПРОИЗВОДСТВА ПОЛИМЕРНЫХ МАТЕРИАЛОВ МЕТОДОМ МНОГОКОМПОНЕНТНОГО ЛИТЬЯ ПОД ДАВЛЕНИЕМ

Валерий Дядичев, Елена Пугачева, Алексей Кильдейчик

Аннотация. В статье произведен анализ факторов, влияющих на качество готового полимерного изделия, выполненного с использованием многокомпонентного литья под давлением.

Ключевые слова: литье под давлением, вязкость, усадка, полимер.