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APPLICATION OF THERMAL ANALYSIS FOR INVESTIGATIONS OF POLYMER POWDERS FOR COATINGS

J. Gretkiewicz and *A. Gladysiak-Kwiatkowska*

INSTITUTE OF CHEMISTRY, THE TECHNICAL UNIVERSITY OF WARSAW, ŁUKASIEWICZA 17, 09–400 PŁOCK, POLAND

Polypropylene coatings obtained by the fluidized bed method were investigated. It was proved that the application of thermal analysis methods for their characterization gave many useful data, as a consequence of the similar conditions of thermal measurements and plastics powder processing. Significant correlations were found between the thermal properties and the standard coating poperties.

Plastics have found wide application not only as construction materials, but also as coating materials. The making of protective coatings from polymer powders has been known for more than 40 years. In the past decade, fast developments have occurred in this field. These coatings are most often applied by means of the fluidized bed and electrostatic deposition methods (about 70% of all applications) [1, 2].

The present article describes only a part of our research work devoted to the use of polypropylene (PP) for coatings. The aim of the work was to investigate the possibility of applying thermal analysis methods to observe the influence of the material composition and processing conditions on the coating properties.

Experimental

Powders of PP homopolymers types J400, B200 and F601 and ethylene-propylene copolymer J330 from the Mazovian Refinery and Petrochemical Plants, Płock, were investigated. As a reference sample, Flamulit WSPE B (low-density polyethylene) from Permetex, FRG, was used. From these polymers, powder compositions containing stabilizers, carbon black, colloidal silica and talc as fillers, and the cross-linking system sulphur-benzoyl peroxides were prepared. On these compositions we determined the melt flow index, the bulk density, the apparent angle, the fluidity and the moisture content.

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Thermal studies were conducted with a derivatograph (m = 150 mg, 293–773 K, air) and a DSC/DSC–2, apparatus (Perkin–Elmer, USA) (m = 2.5 mg, 328–723 K, N_2), to determine the temperatures of the first weight loss, of the maximum rate of decomposition, of the melting and of the crystallization, and the heats of phase transitions, for various heating and cooling rates, temperatures and durations in the melted state. Tme coatings on steel test panels after shot-blasting and degreasing were obtained in a fluid bed with an immersion time of 2 s, for panels heated to 693 K. The coatings were characterized by thickness, appearance, adhesion, scratch resistance (Clemen method) and drawability (Erichsen method).

Results and discussion

The temperatures of first weight loss in air (as in the processing conditions) for several types of PP were similar (533–573 K), but lower than for polyethylene (631 K). Examples of thermogravimetric data are presented in Fig. 1. It can be seen that the temperature found optimum for the coating process (693 K) is higher than that for the first weight loss, but it must be remembered that the contact time at this temperature is very short.

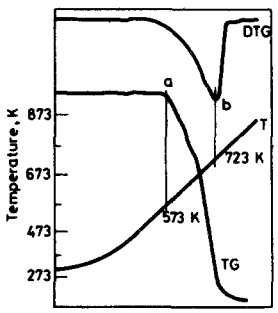

Fig. 1 TG and DTG data for PP type J400

Table 1 Data concerning phase transitions for different PP types

PP type	Melting temperature, K		Heat of transition, cal/g
	DTA	DSC	
J400	433.0	429.5	18.85
J330	433.0*	431.5*	20.51
B200	433.0	430.0	20.94
F601	433.0	430.0	12.77

* temperatures for melting of polypropylene segments in copolymer

The temperature of the first weight loss decreases together with increase of the fineness, which was estimated in the range up to 0.25 mm.

The addition of fillers led to a weak stabilizing effect. The data relating to phase transitions from DTA and DSC are very similar (Table 1).

For further measurements, only DSC was chosen. The heats of transitions for different PP types are similar, which proves their approximate crystallinity. The value for type F601 is lower, which results from the much higher melt flow index. Values for compositions with fillers are lower than for unmodified PP, relative to the contents, which is confirmed in the literature [3].

It was found that, for a constant filler content, this effect is related to its bulk density and chemical character. DSC curves for homopolymer J400 and copolymer J330 are shown in Fig. 2.

Many possible dependences between the thermal and coating properties were analysed. In several cases, significant correlations were found. An example of this is shown in Fig. 3.

To summarize, it can be said that thermal analysis methods together with other methods are essential to acquire a broad view of polymer powders for coating,

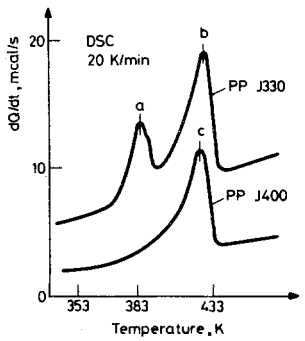

Fig. 2 DSC curves for PP J330 and J400. Melting temperatures for: a – polyethylene segments in copolymer, b – polypropylene segments in copolymer, c – homopolymer

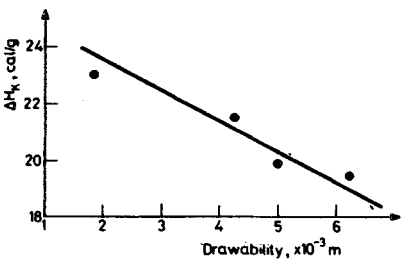

Fig. 3 Relationship between heat crystallization and drawability (Erichsen method), PP J330 filled with carbon black and sulphur

especially because the thermal measurements approach the real conditions of processing.

References

1 Z. Kowalski, Powłoki z tworzyw sztucznych, WNT, Warszawa, 1979.
2 A. D. Jakovlev, V. E. Zdor and V. J. Kaplan, Poroškovyje polimiernyje materiały i pokrytia na ich osnovie, Chimia, Leningrad, 1979.
3 Teplofizičeskije i reologičeskije charakteristiki i koeficienty trenija napolnienych termoplastov (collective work), Naukova Dumka, Kijev 1983.

Zusammenfassung — Durch Fluidisationsverfahren erhaltene Polypropylenbeschichtungen wurden untersucht. Es wurde festgestellt, daß infolge der ähnlichen Bedingungen von thermischen Messungen und Plastpulverisierungsverfahren die Anwendung von thermischen Untersuchungsmethoden zu deren Charakterisierung viele nützliche Angaben liefern. Es konnten eindeutige Beziehungen zwischen thermischen Eigenschaften und Standardbeschichtigungseigenschaften gefunden werden.

Резюме — Исследованы полипропиленовые покрытия, полученные методом движущегося слоя. Установлено, что применение термических методов анализа для характеристики таких покрытий, дает обширную полезную информацию. Найдены важные корреляции между термическими свойствами и общепринятыми свойстами покрытий.