UDC 544. 722. 132

[1]RUDENKO I.V., [1]LEBEDYCH V.S., [1]MYRONYUK O.V., PhD,
[1]SIKORSKY O.O., [2]SAJANYAN A., Prof.

[1]National Technical University of Ukraine "KPI", Ukraine
[2]Texas Technology University, USA

DETERMINATION OF POLYMER SURFACE ENERGY

Проведено співставлення точності методів визначення поверхневої енергії: сидячої краплі та пластини Вільгельмі. Показано, що результати одержані за цими методами є еквівалентними, а отже методи можуть використовуватися в комплексі при дослідженні властивостей полімерних виробів.

Проведено сопоставление точности методов определения поверхностной энергии: сидячей капли и пластины Вильгельми. Показано, что результаты полученные этими методами являются эквивалентными, а следовательно методы могут использоваться в комплексе при исследовании свойств полимерных изделий.

A comparison of the accuracy of determining the surface energy method: sessile drop and Wilhelmy plate techniques. It is shown that the results obtained by these methods are equivalent, and therefore can be used in methods for the determination of polymer product furface properties.

Ключові слова: метод сидячої краплі, пластина Вільгельмі, поврхнева енергія

Determination of surface energy of polymer materials - an urgent task in coating technology and polymer products, which were obtained from the melts technology. In recent years, related areas - such as the technology of polymer fibers as well as all compounds widely used values of the surface energy of the processed materials for the development of the finished product properties.

The basic method of establishing surface energy is the so-called sessile drop technique [1], which deals with the determination of contact anges of test liquid droplets with different surface tension and the subsequent determination of the surface energy according to one of the relevant theories. Most useful for middle-polar surfaces theory is the theory of Owens-Wendt, which deem the surface tension as a two-component value, consisting of the dispersion and polar components.

Sessile drop method, although it is accurate enough can not be used for determining the contact angles of test liquids on samples of unsuitable form, namely those where the surface is not perfectly flat or surface area - is insufficient. In such cases, we propose to use the Wilhelmy plate method [2, 3], which is not limited by the geometry of the specimen surface. This method can be used successfully for the surface energy determination of polymer fibers, flakes, granules of compounds [4, 5].

In this paper, we are comparing the accuracy of the surface energy determination by conventional method of sessile drop and by Wilhelmy plate method.

Objects of the study: prepared films of polyethylene terephthalate (PET), oriented polyethylene terephthalate (for PET) and polyethylene (PE).

To determine the contact angle were used such test liquids: cyclohexane, benzyl alcohol and water. The contact angle by sessile drop technique was determined with the help of angle measuring equipment ScopeTec DCM 510 and Wilhelmy method is implemented on the Axis 520 S. precision balance.

Comparison of the results of research (Table) indicates a substantially complete coincidence of surface energy values for the two methods, the existing differences - within experimental error.

Table - The value of free surface energy of specimens, mN/m

Sample	σ	σ_d	σ_p
Wilhelmy plate technique			
PET	41,2	24,2	17,0
oPET	31,2	27,6	3,7
PE	35,1	24,2	10,9
Sessile drop technique			
PET	41,6	24,2	17,4
oPET	31,5	27,9	3,6
PE	35,7	24,8	10,9

Noteworthy is also the fact of distribution of the surface energy of polymers - oriented polyethylene terephthalate is even more non-polar than polyethylene.

Thus, it was found that the methods of sessile drop and Wilhelmy plate give equivalent results in the study of the properties of the surface of the medium and low polar polymer materials. And may be used interchangeably. A limitation of the sessile drop method is the geometry of the sample, whereas the method Wilhelmy is limited by the contact angle value of the test liquid – it have to be less than 90 °.

References:

1. *K.L. Mittal* Contact angle, wettability and adhesion. – BRILL, 2009. – 397 p.
2. *F.Garbassi*, M. Morra, E.Occhiello Polymer surfaces from physics to technology. – Wiley, 1994. – 462 p.
3. *De Gennes,* P.G. (1985). Wetting—statics and dynamics. Rev Mod Phys., 57(3), 827–863.
4. *Bormashenko, E.,* Y. Bormashenko, G. Whyman, R. Pogreb, A. Musin, R. Jager, Z. Barkay. (2008). Contact Angle Hysteresis on Polymer Substrates Established with Various Experimental Techniques, Its Interpretation, and Quantitative Characterization. Langmuir, 24, 4020–4025.
5. *S. Herminghausa*. (2012). Wetting, spreading, and adsorption on randomly rough surfaces. Eur. Phys. J. E., 35– 43.