

## Thickness Uniformity of Flexible Package Material and Package Cost

**Abstract:** A better controlling of film thickness uniformity can help reduce package cost and lessen the effect of crude oil price rising on package enterprises. This article provides a detailed introduction to the importance of thickness uniformity to product package. It also conducts a further discussion on testing methods of film thickness and coating thickness.

**Key words:** thickness , film,cost control, mechanical thickness testing, uniformity

The continuous rising of crude oil price made the cost of polymer materials also rises greatly. Under the intensive market competition, trying to transfer the increased cost completely or partially to customers by increase sell price will not be accepted by customers. In addition, such an action is equal to destroying the credit of manufacturer. At present, there are mainly two ways to efficiently reduce package cost. The first way is to intensify research efforts of new type polymer with an aim to reduce material consumption or reduce package cost on a premise of not reducing package properties as far as possible. The other way is to controlling thickness uniformity of materials with efficient testing methods, by which rejection ration of package can be reduced. Relatively speaking, the latter one is easier to realize and the present thickness testing technology can help to reduce package cost.

### 1 Importance of Film Thickness Uniformity

Thickness uniformity of materials is one of the prerequisite for possessing special protective function. Taking material with barrier property as an example, being the most important layer of barrier film, uniformity of barrier layer has a direct influence on the overall barrier property of material. Barrier property of the film depends partially on the material of barrier layer(material with good barrier property at present usually use aluminum foil, aluminum-plating, plates silicon oxide compound, PVDC, EVOH and so on as the barrier layer) and partially on the thickness of barrier layer. Generally, the thicker the barrier layer, the better the barrier property of film. However, when thickness of barrier layer reaches certain extent, barrier property of the film tends to become stable and will not increase with the thickening of barrier layer. High barrier material is very expensive. This is why thickness of barrier layer has a direct influence on overall cost of barrier film. The application of multilayer complex film can efficiently reduce package cost. Because the thickness of its barrier layer is only 10% that of integral film thickness, some of them is even only 5  $\mu\text{m}$  (or less). But the controlling of barrier thickness is very difficult. Nonuniformity of barrier layer may cause weak spot on it and will influence the stability of overall barrier property, which will result in worse barrier property in certain part of package. This can cause product deterioration within quality guarantee period. Moreover, to some film (especially film of good transparency), variation of barrier layer thickness may influence the outward appearance and color of film and reduce the display effect of product.

Uniformity of film thickness can also bring difficult to film printing and relevant operation procedures. Taking the commonly used domestic gravure printing as an example, controlling of printing tension, which has relationship with film material, film thickness and uniformity of thickness, is of vital importance in quality guarantee of printed matter. Fail to controlling the printing tension will cause inaccuracy of overprint. In addition, nonuniformity of film thickness can also cause winding up and dislocation after being printed.

During the manufacture process of multilayer complex film, nonuniformity of any of its layer will cause nonuniformity of subsequent handling and made thickness uniformity of the finished film much worse. If using such kind of film as external packing, there may be mechanical weak spot during package using. Under bigger impact of external force during process of packing, transportation, storage and sale, there may be crack and holes appearing in the weak spots, which will result in the reducing or completely losing of special storage function of material.

### 2 How to Test Film Thickness

In film processing and manufacture, thickness testing is one of the most common indexes in film testing. Thickness testing can be further divided into film thickness testing and coating thickness testing. Since film thickness refers to the sum total of each resin layer, thickness distribution of each resin layer will also have difference without good thickness uniformity of integral film. It is no doubt testing of coating thickness is more favorable for the efficient controlling of thickness uniformity of each layer. But to accurately control the thickness of each coating layer in multilayer film, great investment is needed on corresponding thickness testing instruments and the investment will increase with the growth of layer numbers, which will bring big economical burden to enterprises. A rather economical way is to carry out thickness testing only to some expensive coating layers, while at the same time strengthen integral thickness testing of the film to realize an efficient controlling of the thickness uniformity of each layers.

Thickness testing instruments can be divided into online testing instruments and non-on-line testing instruments (detailed information can refer to the article named Testing Method of Film Thickness). A coordinate using of these two kinds of instruments is the most ideal way. On one hand this is because non-contact measurement mode adopted by online testing instruments made thickness testing of flexible package material unable to avoid the bigger data fluctuation resulting from compressibility or unevenness of material. However, contact measurement mode (such as mechanical thickness testing adopted by Labthink CHY-C1) provided by non-on-line instruments can make up the deficiency of online instruments efficiently. One the other hand, although online testing instruments can efficiently control thickness uniformity of one batch film, it is not applicable to random sample testing of finished film.

On-line thickness instrument can obtain thickness data with the rapidest speed. With timely adjustment of production parameters, it can reduce thickness variation of materials and shorten working time of the production line. However, corresponding scan frame is needed, which imposes certain limitation on instrument reuse. Moreover, the expenditure of on-line instruments is much more expensive than that of non-on-line instruments in terms of price, operation and maintenance. With small volume, non-on-line instrument is cheap and easy to operate. But it has a lower reaction to parameter adjustment of production line. Non-on-line instruments are abundant in type. Among that, mechanical thickness testing technology has the most powerful application without selectivity on specimen and will not be affected by product color, component variation or surface reaction. Moreover, by applying certain press to measuring surface of specimen during the process of testing, such instruments can avoid the bigger data fluctuation caused by the compressibility nature or surface unevenness of material. In addition, due to the compressibility nature of film, disparity in thickness testing of the same film by various thickness testers is a common case. Therefore, it is very important to select instruments strictly according to the specifications of standard.

### 3 Prospect

Strengthening the testing of thickness uniformity can reduce rejection ratio of package material and achieve the purpose of cost saving. The compressibility nature of flexible package material made mechanical thickness testing instruments always the first choice in thickness testing of various flexible package materials. However, contact measurement of mechanical thickness testing confined its development in online testing field. Therefore, to efficiently control thickness uniformity of materials, an optimal method is to simultaneous possessing online and non-on-line thickness testing instruments, which should be decided by enterprises based on the composite factors such as material type, controlling requirement of thickness uniformity and equipment budget.