

## TACK FORCE MEASUREMENT OF ADHESIVE MATERIALS

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**Abstract** – In this paper a newly developed tack-meter is introduced. One of the major features of this tack-meter is pushing the probe wrapped in a PET film against a sample, and during pulling apart the film from the sample tack of a material is measured. And each material's tack is compared by the adhesion to a PET film. The quality of a PET film is stable as a comparison contrast material. Another feature of the tack-meter is that it is operated full automatic and it can measure continuously at high speed. Also the tack-meter is improved in subjects of various existing tack measuring methods. They are reproducibility, accuracy of measurement, and measuring speed. It is designed suitable for use in the manufacturing line in respect of a size and easy operation.

**Keywords** : tack, adhesion, PET film

### 1. INTRODUCTION

Tack is defined as the property of an adhesive that enables it to form a bond of measurable strength immediately after adhesive and adherend are brought into contact under low pressure[1 - 3]. Tack has been known by many names but it difficult to define. Tack, finger tack, initial adhesion, wet grab are so called quick stick[4]. Tack is a kind of adhesive power to a surface under very light pressure. It is called pressure sensitive adhesive[5]. It is determined by the ability of the adhesive to wet the surface contained quickly. Tack is the capability for the adhesion object to be pushed on sample material with light pressure for a short time. Therefore, for evaluation of tack, we have to measure the very thing for contact process[6][7]. However, a problem in measuring adhesion, we must measure a power to dissociate an object and a sample material after contact for a short time[8]. Consequently, tack is substituted for evaluating contact process by measurement of dissociation power.

### 2. MESUREMENT OF ADHESION

The inclination rolling ball tack[9], the rotation ball tack tester, the loop tack[10][11], the quick stick, rotating drum tack[12], and probe tack are used as measuring methods of tack in laboratory use. In the manufacturing line, an organic-functions examination called the feeling of a fingertip, so-called finger tack, has been popular as a measuring method of tack.

There are problems in the finger tack method. This method requires an examiner's degree of skill. The individual difference of the finger surface, i.e. a fingerprint, contamination degree of oil, and moisture, affect judgment[13]. In order to solve these problems in measurement of stress change of the contact and exfoliation a load cell with a probe, called probe tack, has been developed[14 - 18].

In recent years, the value of adhesive has come to be required for quality control in manufacturing lines. Tack of a material is represented according to the adhesive power between materials. Analysis of fine distribution and variation of adhesive power of materials is requested for higher quality level of industrial products. Another request in manufacturing lines is full-automatic measurement of tack. According to the conventional measuring methods, a specimen shall be prepared beforehand, and the power of pulling them apart is measured. One of the major problems in the conventional measuring system is preparation of specimens. It is necessary to cut off the piece of a sample in advance. In case a sample is taken out, a sample will be soiled or its character will be changed. Consequently, it will not be able to measure the tack of original condition. Furthermore, it is difficult to take data of nearby points and analyse fine distribution of tack.

Authors have developed a full-automatic instrument of adhesive measurement which solves the problems of these former systems should be solved. This paper presents details of the developed full automatic measuring system of tack and application to industrial manufacturing lines.

### 3. PRINCIPLE

The developed tack-meter consists of a load cell i.e. a load cell, an electric transducer, a measuring probe, a probe cover film, a film dispenser mechanism, a sample support stand, a measuring electrical instrument, a display of tack value, data acquisition interface, and data manipulation microprocessor system. Fig. 1 features the over view of tack-meter. A measuring probe covered by PET film is pressed to an adhesive object for measurement, and measures the force of pulling apart from the object.



Fig. 1. Over view of tack-meter

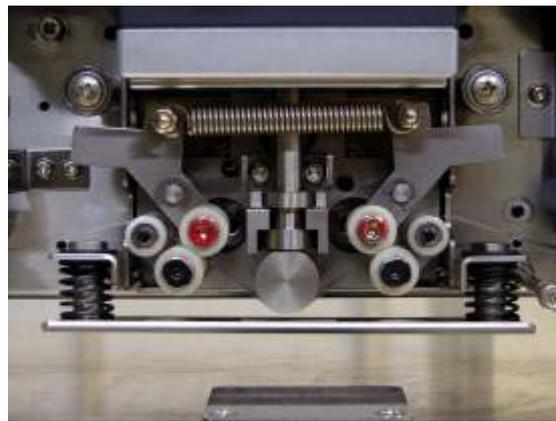


Fig. 2. Measuring probe and its cover film

Fig. 2 shows a close view of a measuring probe. A PET film is used to cover a probe's surface. Contaminated film surface is rolled up and new film surface is always provided for measurement. A series of measurement operation is performed within in 2.2 seconds.

### 3.1. Measuring Technology

The reproducibility in measurement is very important. Not only this equipment keeps the same condition of probe surface of the probe, but also the forcing pressure of a probe and forcing time is precisely controlled. The force control is realized by the high-speed microprocessor feedback control. A load cell is used as a force gage transducer. It is connected to a measurement probe, and it is used for force control and to measurement of a pulling-apart power of PET film from a sample.

### 3.2. Measuring Procedure

Fig. 3 expresses the brief sequence of measuring procedure of the developed tack-meter.

*Step 1.* A sample is placed on a support stand. The surface of a support stand is processed which prevents adhesion. The probe connected to a load cell is pressed against a sample's surface.

*Step 2.* A PET film is fixed and it is made not to loosen on both sides of a probe. And a probe is pulled up after pressing a sample in fixed pressure and fixed time. The peak value of the force of the load cell's signal is memorized as tack data.

*Step 3.* After measurement is completed, a PET film dispenser sends the film for the next measurement and the film with unclean surface is rolled up.

**3.3. Measuring conditions**

The press force of measuring probe is 6,500gf. for 300 milliseconds. The size of a measuring probe is 25.4 mm ( 1 inch ) in diameter. The quality of a PET film is stable as a comparison contrast material. The cover PET film size is 15mm (width) x 30 meters. The thickness of a PET film is 0.038 mm. The capability of the developed equipment was evaluated. Average measuring speed for each point is 2.2 seconds.

**3.4. Measuring parameters**

The control pattern of measurement probe operation is shown in Fig. 4. A probe descends at high speed from a standby position at first, and if it comes to a height of 20 mm from a sample, it will change downward speed to a low speed. The standby position was prepared in order to make it not hurt the probe itself in

the case of samples are exchanged.

The approach speed of a probe to the surface of a sample is set as 30 mm per second. And the pressure which forces a sample is set as the 6,500gf., and forcing time is set as the 300 millisecond. Measurement of tack is performed in operation by which a probe is torn off by 30 mm per second. The major parameters of a measuring operation are shown in Fig. 4.

Fig. 5 shows the out-put voltage of force gage, a load cell, connects to the probe. This chart shows the value of force in each of measuring sequence step, press the probe and pulling-apart from a sample. The key factor of the reproductively in tack measuring is to keep the force and time to a sample surface shall be constant. The accurate force and time control is realized by the high-speed microprocessor feedback control technology.

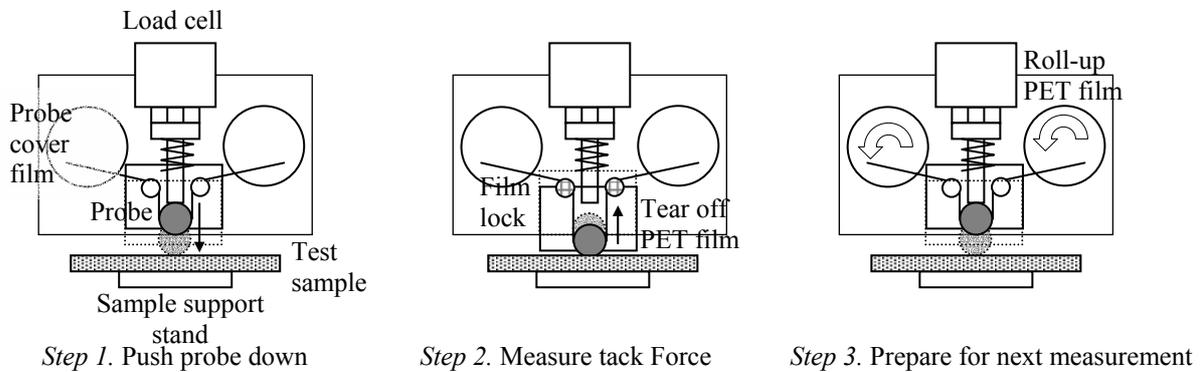


Fig.3 Sequence of measuring procedure

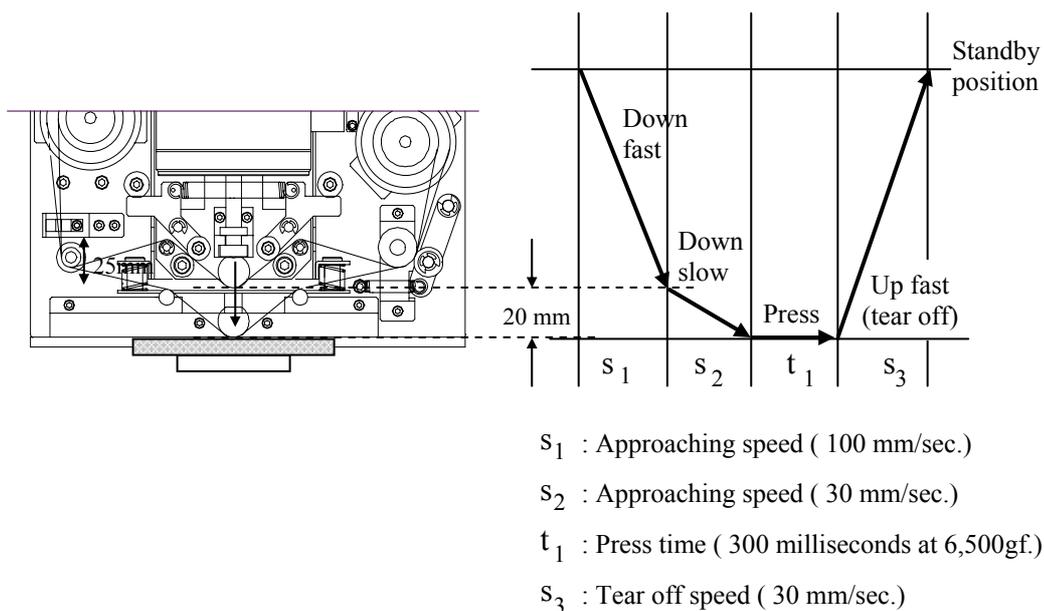


Fig. 4 Control pattern of measurement probe operation

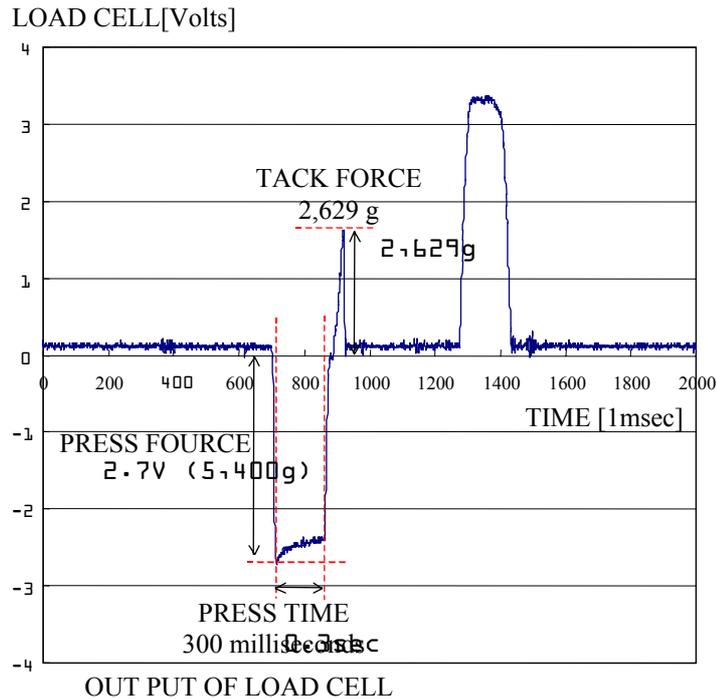


Fig. 5. Out put of load cell connects to the probe

#### 4. RESULTS

Fig. 6 shows a measurement example which employed the feature of the developed tack-meter efficiently. The distribution of the tack of a rubber sheet sample was measured using the developed equipment. 25 cm x 25 cm of two samples, cut out from the 55 cm width sheet, are prepared. The measured tack distribution in Fig. 6 shows that the distortion of tack force on each sample is clearly two dimensionally mapped. Adhesives of the sample tape are variegated from 150 to 450 grams.

We can also understand its variation geometrically. It being able to say from comparison of two sheets is that the tack is changing from the centre of the original sheet symmetrically. On the whole, as for this change, the centre of a sheet means that the tack is weak. This phenomenon has suggested a possibility that the belts and rollers of conveyers which transport this sheet are concentrating driving force on the central part of the rubber sheet.

In the method of the conventional measurement, the sample of a measurement object have to be cut off and measured. In this developed tack meter, since it measures tack by hitting a probe against a measured object directly, it is unnecessary to cut off a sample beforehand.

#### 5. CONCLUSION

A tack-meter was presented as a new apparatus of tack force measuring. The tack-meter is designed for industrial use, reproducibility, accuracy of measurement, and measuring speed are considered high priority in specifications. Consequently, designed suitable for use in the manufacturing line in respect of a size and easy operation.

As a result of applying to some actual production lines and evaluating tack measurement of material, it is admitted that this equipment is specification applicable to the production line of the manufacturing environment enough. Of course, a performance can be demonstrated also as an evaluation machine in the conventional laboratory, and it can be utilized enough.

One of the major improvements of the tack-meter is full automatic measuring. It will be useful to measure the distortion of tack force on a sample of continuous sheet form. By using this apparatus, we can measure each sampling point in 2.2 seconds. If a tack-meter is connected to PC terminal of a production line, online data collection, monitoring, and supervise are possible via a network system of a manufacturing plant. Now tack can be monitored and supervised for 24 hours, and automation of trend grasp and quality monitoring are realized.

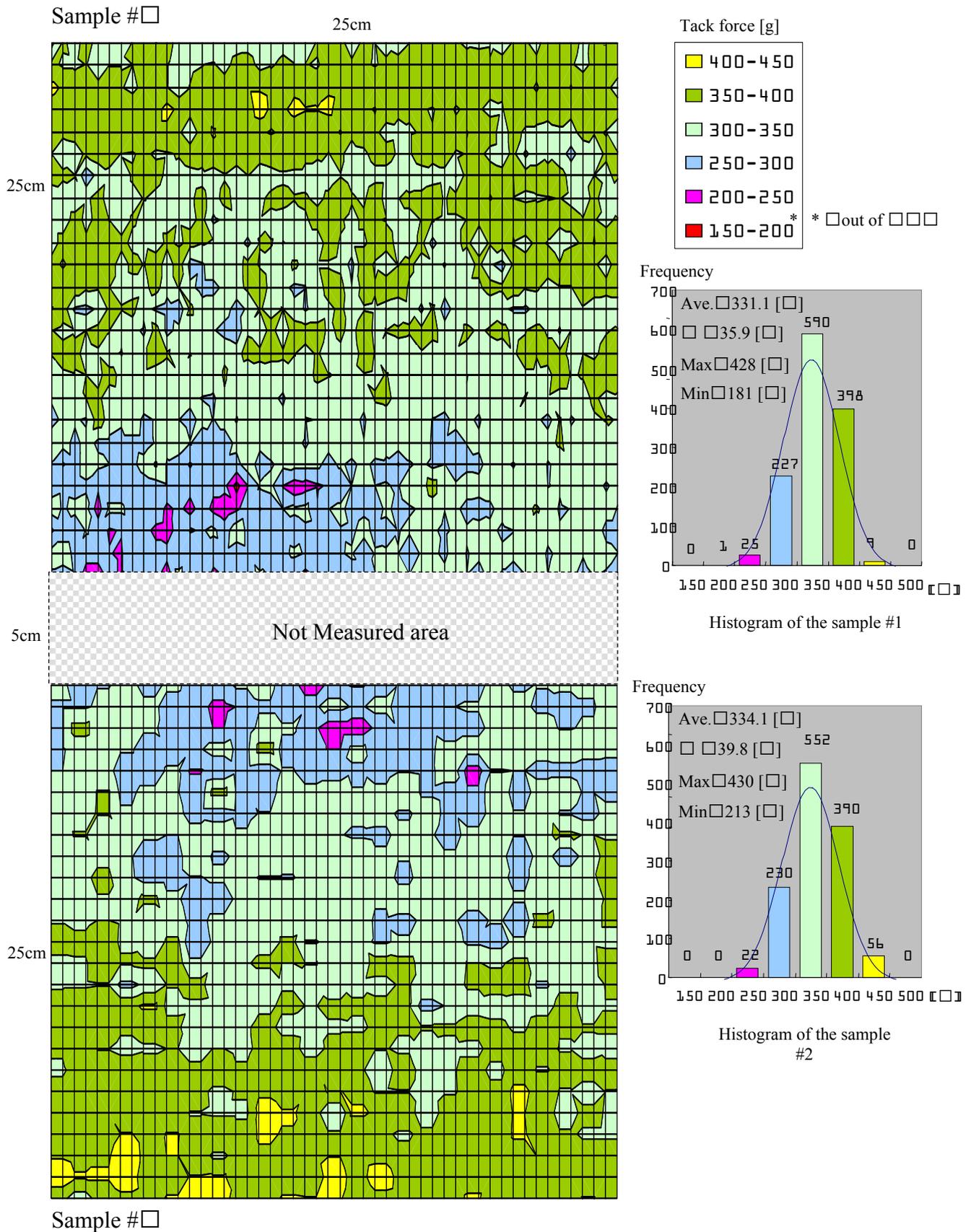


Fig. 6. Tack distribution of samples

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