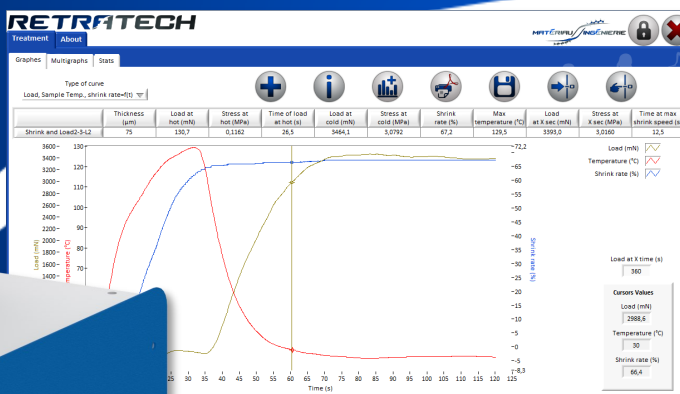


## RETRATECH

### CHARACTERIZATION OF THERMO-SHRINK FILMS

Commercial reference(s): M016-00 - M033-00



Type(s) of test:  
Thermomechanical

Material(s):  
Thermoplastics  
Biomaterials

Standard(s):  
ISO 14116  
DIN 53-369  
NF T54-125

#### INTRODUCTION

Thermo-shrink films represent one of the main applications of plastics. They are widely used for packaging ensuring effective protection to corrosion and moisture, while maintaining the aesthetic of the wrapped object (transparency, printing, gloss, etc.).

To induce the shrinkage, films are stretched when they are warm to give an orientation to the macromolecules and then cooled to set their characteristics. To initiate the shrinkage, films are reheated during their use.

Even if the phenomenon is theoretically simple, control

the shrink conditions or develop new films need the use of specific and accurate methods.

The **Retratech** measures the following parameters:

- Shrink rate ;
- Shrink (or hot) force ;
- Contraction (or cold) force ;
- Operating temperature range.

The **Retratech** exists with one or three stations of force measurement. ■

## MATERIALS

The **Retratech** was originally developed for the control of films based on polyethylene (PE), the most common family of polymers for this segment : Low density polyethylene (LDPE), Linear low density polyethylene (LLDPE), Metallocene linear low density polyethylene (PEBDLm).

Nevertheless, all thermo-shrink films (mono or multi-layers) can be tested : Polypropylene (PP), Polypropylene metallocene (PPm), Polyethylene terephthalate (PET), Polyamides (PA), Polyvinyl chloride (PVC), Etc. ■

## AIM

Thermomechanical properties of thermo-shrink films depend on their structure but especially of the manufacturing conditions. In addition, current trends for sustainable development imply :

- A reduction of the films thickness without loss of performance ;
- A lower operating temperatures range ;
- The use of new bio-based and/or biodegradable materials.

The **Retratech** allows a global visualization of the shrinkage phenomenon by following the force and the displacement of samples put in a thermoregulated oven. Thanks to these informations users are able to know the thermomechanical phenomena occurring during the heating and cooling steps (glass transition, melting, crystallisation, etc.). ■

## WHAT IS A SHRINK FILM?

Thermo-shrink films represent of a wide variety of plastic materials designed to shrink after heat .

They are obtained by stretching or blowing a thermoplastic material near its softening point (melting point for semi-crystalline polymers and glass transition for amorphous polymers). Then the material is frozen in this state by a sudden drop in temperature (quenching).

This method therefore causes an orientation of the macromolecular chains which occurs through stresses in the longitudinal direction (i.e. in the direction of extrusion) and/or in the transverse direction.

Different kinds of process exist :

- Biaxial or monaxial orientation ;
- Flat or tubular format ;
- Simultaneous or sequential machine direction (MD) and transvers direction (TD) deformation.

Stresses are released when the film is subjected to a temperature close to the softening point. This input of thermal energy allows macromolecules to regain some or all their original form which imply a dimensional retraction and therefore a shrink force. Thermo-shrink films are *single use shape-memory* like materials. ■

## PRINCIPLE

The **Retratech** is basically an oven equipped with two or for stations that simulate the passage of films in a shrink tunnel. The tests shall be carried out in both machine direction and transverse direction (to check whether the film is mono or bi-oriented).

Test pieces are placed on a four stations bracket beneath a mobile oven: one station is connected to a displacement sensor (indicative method); the others are connected to a force sensor (ISO 14116 method).

The oven is then lowered on the test specimens simulating the time of passing through a shrink tunnel. The thermal program (temperature, duration) is controlled by a PC software.

During the test, force, displacement and temperature in the vicinity of the sample are recorded ■

## METHODS

The **Retratech** offers two distinct and complementary testing methods :

### A/ Characterization of the film behavior under thermal ramp (Fig. 1)

The thermal program is a single ramp ( $5^{\circ}\text{C.mn}^{-1}$  generally). This test determines :

- $T_1$ , the shrinkage start temperature ,
- $T_2/T_3$ , the temperature range of optimal shrinkage. The longer this gap, the more the film is easy to use.

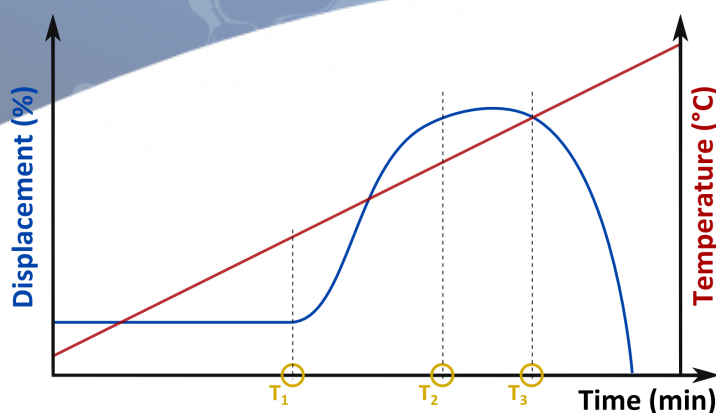


Figure 1: Example of curve obtained with a temperature ramp

This method is useful :

- To control films from a supplier at delivery ;
- To characterize a new film ;
- To compare different formulation of films.

## B/ Characterization of the film behavior under isothermal (Fig. 2)

This method is a simulation of the passage of the film into a shrink tunnel. It allows to set the temperature and the heating duration. Force, displacement and temperature are measured continuously.

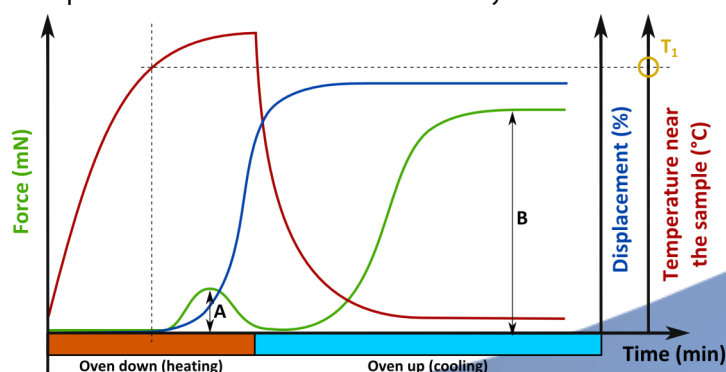


Figure 2: Example of curve obtained with an isothermal

First, the oven is up and heated at the set temperature. When this temperature is reached, samples are placed on their measurement stations.

Then the test starts and the oven is automatically lowered by means of pneumatic cylinders.

Afterwards, when the programmed time is reached, the oven gets up when the programmed time is reached so samples cool down at room temperature.

The following characteristics are determined:

- $F_1$ , shrinkage (or hot) force ;
- $t_1$ , time at  $F_1$  ;
- $F_2$ , contraction (or cold) force ;
- % of maximum shrink rate.

Several tests are carried out in machine and transverse directions (determining the orientation of the film) and then treat statistically.

The temperature near the sample is not the same as the oven set temperature. The correspondence is determined by preliminary tests.

## DESCRIPTION

### ◆ RETRATTECH (Fig.3)

The device consists of an oven moving following two positions : up (or open) and down (or closed). In *down position*, the oven rapidly heat up samples. In *up position* allows to cool the samples in the open air.

One sample is attached to a force sensor for measuring the cohesive strength. The other sample is connected to a linear displacement transducer indicating the deformation (shrink) of the film.

A thermocouple is used to control the temperature reached by the samples.

These three measures (force, displacement, temperature) are continuously saved to the Retratchtech software .

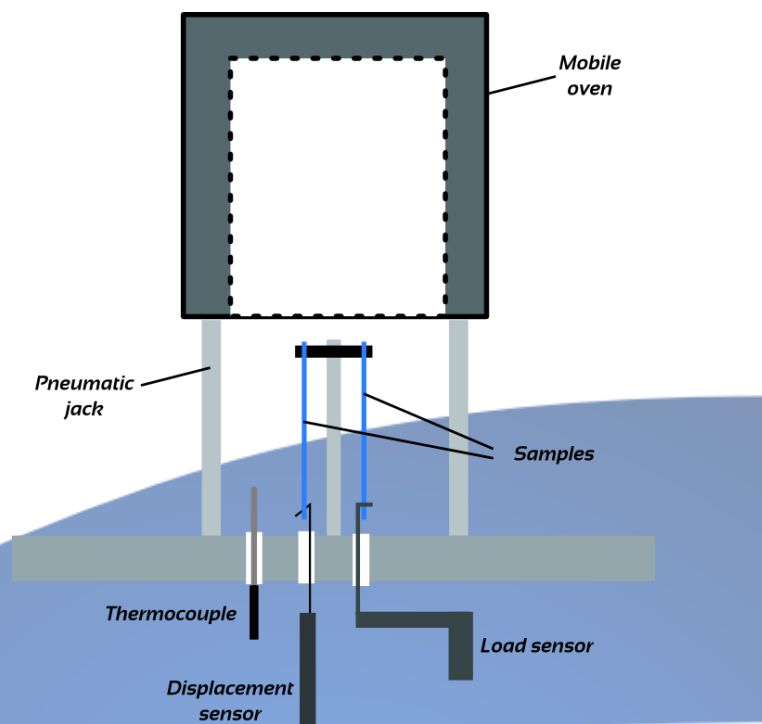


Figure 3: Schematic diagram

### ◆ The software

The **Retratchtech** is PC controlled via a suitable software : control (temperature, oven cooling), data acquisition (force, shrinkage, time, temperature) and treatment.

The connection is made via 2 serial ports for maximum reliability.

The software is compatible with Windows® XP and later versions.

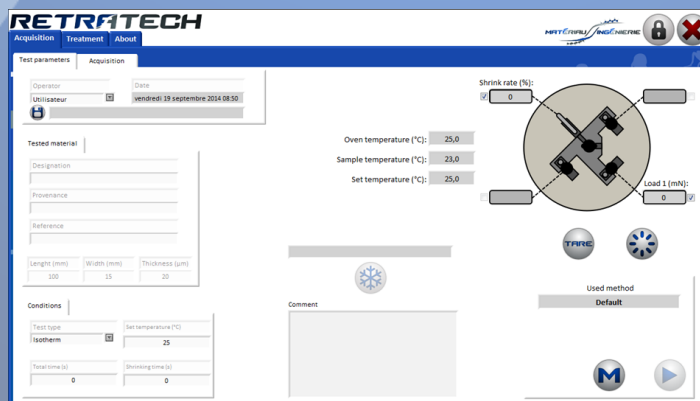


Figure 4: Setup test screen

The software is easy to use. It can:

- Learn the characteristics of the material
- Configure the thermal program (ramp, isothermal, etc.)
- Choose the exposure time.

The data treatment are in agreement with ISO 14616 :

- Shrink and force as function of time ;
- Temperature near the film ;
- Thermal program;
- Calculation of characteristic points (max values, hot and cold strength , etc.) ;
- Report printing.



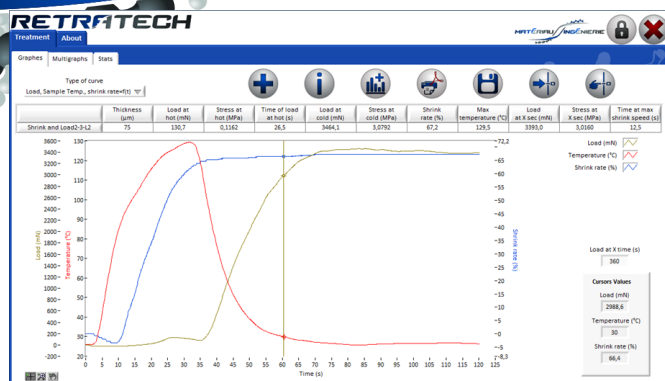


Figure 5: processing result

#### ◆ Sample film for a test Retratche.

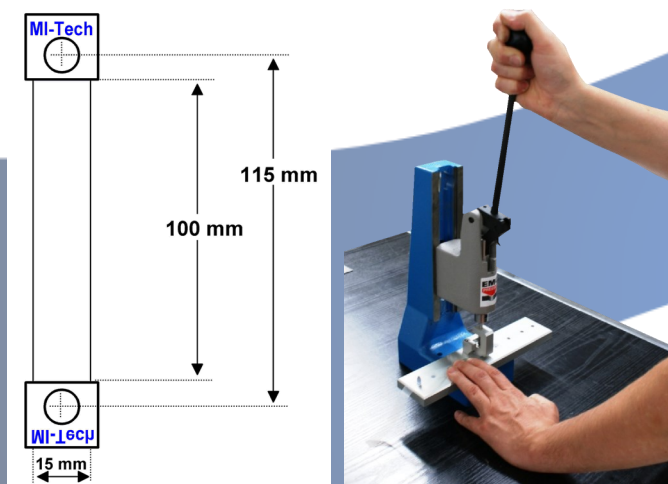


Figure 6: Specimen dimensions and preparing tool.

Prepared using a specific tool, the specimens thus obtained have strictly identical dimensions.

## CURVE ANALYSIS

#### ◆ Standard curve commented (Fig. 2)

- $t_0$  to  $t_1$ : **Oven descent** : Tiny elongation of the film due to thermal expansion.
- $t_1$  to  $t_2$  : The temperature of the film reaches its softening point. Internal stresses are released and the film shrinks. At the same time the film develops a retraction force of very small intensity (A). This great shrink associated with low strength ensure that the film gently follows to the shape of the package.
- $t_2$  to  $t_3$  : **Rise of the oven** - Dimensional shrinkage of the film is low. The film develops at the time a very large clamping force called contraction force or cohesion force (B). It is this force which maintains the package in use.

The characteristics are:

- The shrink rate in MD and TD.
- The hot shrink force in MD and TD.
- The cold contraction force in MD and TD.
- The operating temperature range between the beginning of shrink and the melting/creep.

#### ◆ Shrink rate

Generally, a shrink film is considered bi-oriented if the difference between the MD shrink rate and the TD shrink rate is  $\leq 10$ , and considered mono-oriented if this difference is  $> 25$ .

#### ◆ Shrink force

This force is weak so the film can wrap smoothly the most fragile objects and marry the most advanced forms without tearing.

Usually this force is between 0.1 and 0.8 daN.cm<sup>-2</sup> depending on shrink rates and qualities of films.

#### ◆ Contraction force

This force develops upon cooling. It represents the strength to tight/block the object.

According the polymer nature and extrusion technologies used, this force varies from 10 to 18 daN.cm<sup>-2</sup>.

#### ◆ Operating range

The shrink phenomenon starts when the film is subjected to the temperature used to quench the film after the extrusion.

If the film is subject to an higher temperature, the shrink will takes place with a lower shrink force. With the increase of temperature, the film will also start to creep. Finally, the operating range ends at a maximum temperature beyond which the creep is higher than the shrink.

A film having a wide operating range is useful notably for shrink tunnels of poor temperature control. Generally the operating range of temperatures varies from 8/10°C for standard thermos-shrink films to 20°C/25°C for high performance thermos-shrink films.

## TWO VERSIONS

#### Version 2 measurement stations - Ref. M016-00

This version is equipped with :

- 1 force measurement station ;
- 1 displacement measurement station.

#### Version 4 measurement stations - Ref. M033-00

This version is ideal for making a large number of tests and is outfitted with :

- 3 force measurement stations;
- 1 displacement measurement station.

This last is not duplicated as shrink rate is only "indicative" according to the ISO 14616 standard.

## OPTIONAL ACCESSORIES

#### Sample preparation tool - Ref. M016-13

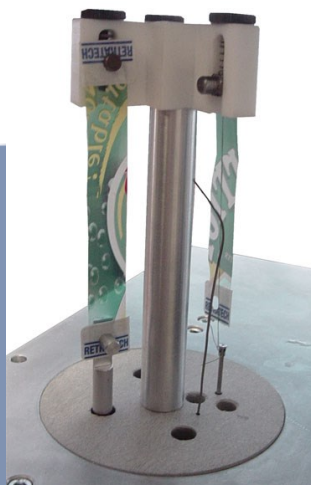
Sample preparation is crucial as it has a great influence on the results. It makes it easy the precise positioning (parallelism and distance between labels), fixing and perforation of labels.

## DELIVERED ACCESSORIES

- ⇒ Roll of 1000 fixing stickers ;
- ⇒ IEC-type power cord ;
- ⇒ Calibration certificate ;
- ⇒ User manual ;
- ⇒ CE certificate ■

## CONSUMABLES

- ⇒ 1 roll of 1000 fixing stickers (ref.: MO16-04)
- ⇒ 5 rolls of 1000 fixing stickers (ref.: MO16-05)
- ⇒ 10 rolls of 1000 fixing stickers (ref.: MO16-06)■



## TECHNICAL SPECIFICATIONS\*

### Retratrech dimensions:

#### - Size :

- Length	500 mm
- Depth	400 mm
- Height	600 mm

#### - Weight

» 30 kg

### Power supply

230 V, 50 Hz

### Air supply

6 bars

### Sample dimensions:

- Effective length	100 mm
- Total length	140 mm
- Width	15 mm

### Load measurement:

- 1 daN	
- Zero offset	± 5 mN
- Sensibility	0.1 mN

### Shrink rate measurement:

- Shrink rate min.	-12%
- Shrink rate max.	90%
- Zero offset	± 1 mm

### Frequency:

15 Hz

### Temperature measurement:

- Temperature min.	RT
- Temperature max.	300°C
- Sensibility	± 1°C

### Software:

- Version	Windows® XP, and later
- Languages	English/French
- Connection	Serial port (x2) ■



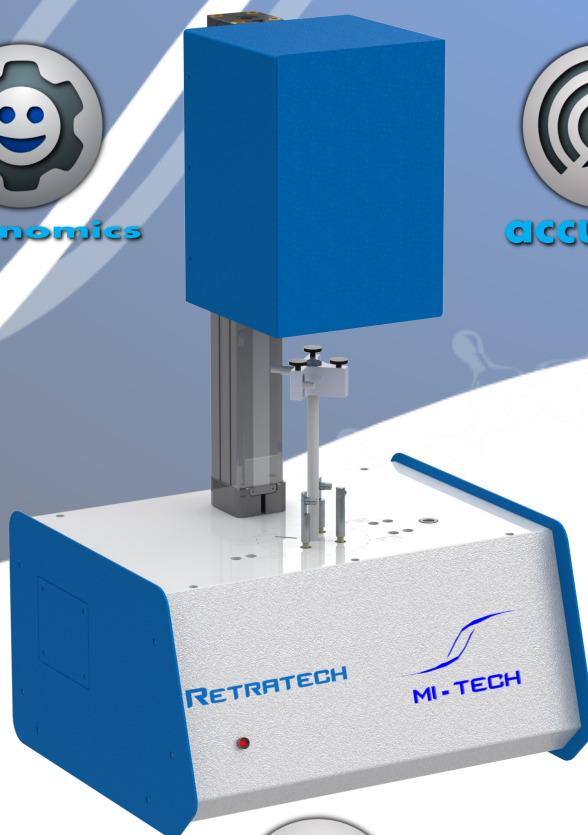
ergonomics



accuracy



smart



industrial

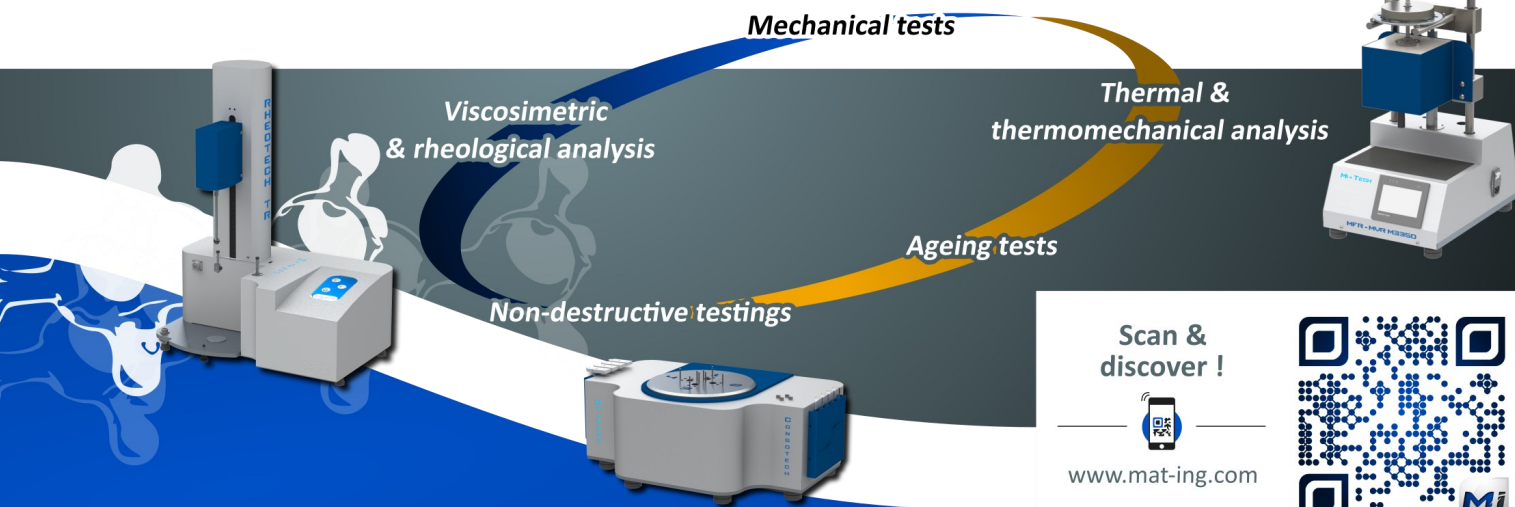
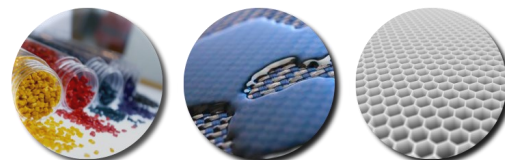


security

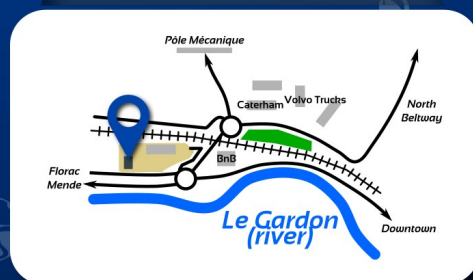
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