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DOSSIER: Mechanical tests on plastics with a tensile testing equipment

For the determination of the mechanical properties of plastic material, IBE-BVI has a wide range of equipment.

The analysis of the mechanical properties is essential for the development and optimization of (new) materials, for quality control or to provide information to make up technical sheets.

A very important equipment is the tensile testing machine, where a big range of analysis and methods can help us to test polymers and composite materials.

First of all, the determination of the ultimate tensile strength and the strength at break, are the most common definitions used to specify plastics. Hereby we cannot only analyze thin plastic sheeting, but also all kind of plastic package materials. These measurements are performed according different ISO and ASTM standards, depending on the type of product and depending on the information you want to achieve.

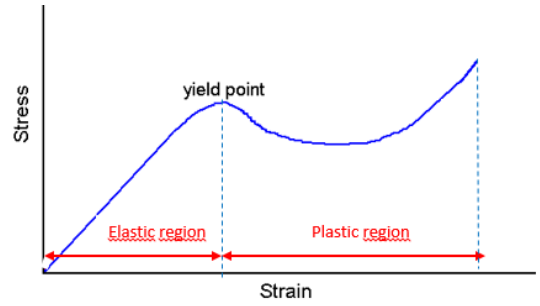
The force that is needed to stretch (elongation) and to break the material gives us an idea of the strength of the plastic. The tensile testing machine clamps each end of the sample and stretches it until break with a predetermined speed according to the used standard. These measurements gives us a stress-strain curve whereby stress is determined as the force applied on the sample divided by the cross-sectional area of the sample and strain is any kind of deformation, including the elongation. The plot of these measurements gives us a lot more information than 'simply' strength and elongation.

The elasticity of a material, which can be retrieved from the Elasticity Modulus that is measured in the first part of the plot gives us an idea about the stiffness of the material. The Modulus is obtained by dividing the calculated stress by the elongation. At IBE-BVI we use an extensometer, which is capable to determine the exact elongation of the material at very low speed and at a certain force.

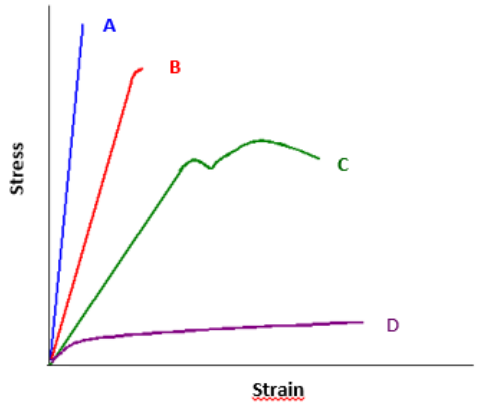
Elastic elongation is the amount of elongation that you can reach without permanent deformation of your polymer. This means that after this elongation, when the force is released, the sample will snap back to his original length.

The point where the elasticity stops and where permanent deformation is observed after stretching, is called the 'Yield Point'. The force (Yield Strength) and the elongation at this point are important parameters that will help to define the characterizations of the material.

After this point, the plastic region starts, in this stage the behavior of the polymer tells us how well the material resists deformation. This is also called the plasticity of the material.



The slope of the plotted curve, gives us immediately a good idea of the plasticity of the material. When the slope of the plot is steep (= high Tensile Modulus), the material resist very well deformation. But when the slope is gentle, the plastic has a low Tensile Modulus, which means it will be easily deformed.



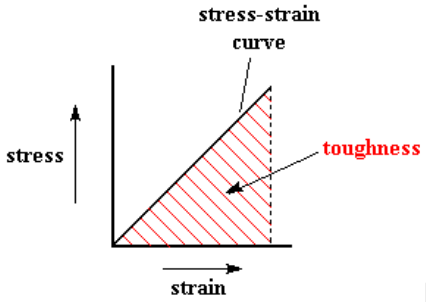
A: Brittle material

B: Strong material, not ductile

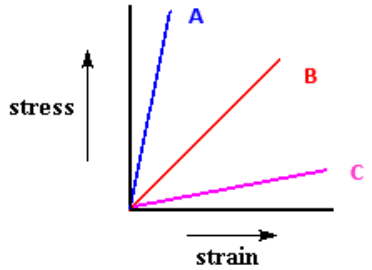
C: Ductile material, that deforms in the plastic region

D: Plastic material, deforms very easily

Another parameter of the material is the toughness that will be calculated from the area underneath the plotted stress-strain curve. It is the energy that a sample can absorb before it breaks.



This differs from the force that is needed to break a sample! A strong sample is not necessary tough and vice versa.



A: Strong, not tough

B: Strong and tough

C: Not strong and not tough

Another tests that can be executed with the tensile tester is de determination of the tear resistance of plastics, according to the 'trouser-method' (ISO 6338 and ASTM D1938).

Also the sealing properties of a foil (according to ASTM F88) can be determined with our tensile tester. The measurements can be performed on existing sealed material, but we can also make the seals ourselves. Hereby we are producing a seal window for the foil. The seal itself is forced to open on the testing machine (during a defined distance) and the average force that is needed to open the seal is called the seal strength. It is important to observe the behavior of the seal and its failures. The seal can open, delaminate, tear or even material break can occur. Taking all of these parameters into account, we can define the optimal sealing parameters for this film.

The tensile tester is also capable to perform compression tests. For example on plastic cups (with or without lid) when we want to know the strength and/or the impression during compression. The material is compressed with a constant speed (depending on the used standard) between 2 horizontal compression plates.

The puncture resistance of foil is also a common used analyses and can be performed according to ASTM F1306 and MIL-STD-3010. The sample is clamped and punctured with a conical probe. The force needed to break the foil is measured.

Another kind of puncture resistance is the one used to test medical waste containers and their resistance to puncture with needles. The container itself will be tested with a needle and must withstand a certain minimum force, according different standards. This minimum force is important for the certification of these containers.

There are a lot of possibilities to test plastic materials with our tensile tester and this according to different standards. However, sometimes this isn't enough and therefore we think along with our customers to perform customized tests. There are a lot of possibilities for example durability testing for which cyclic programming is needed or the opening and/or closing of different types of packing for which tailor-made holders are designed. The possibility to program our tensile tester custom-made gives us a lot of opportunities to compare materials and their applications, even when no package material is involved.

If you don't ask, we cannot try to help you!

Info and test request: see our website

Contact: An Van Geite