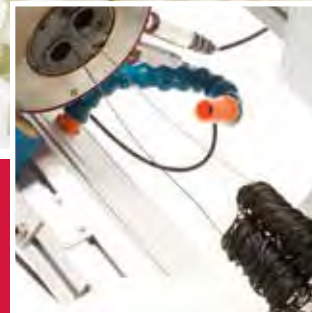
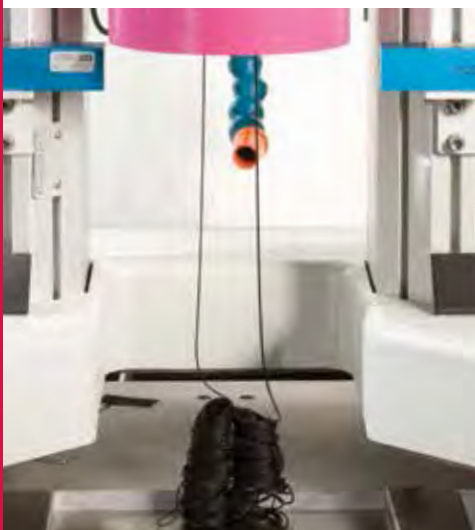
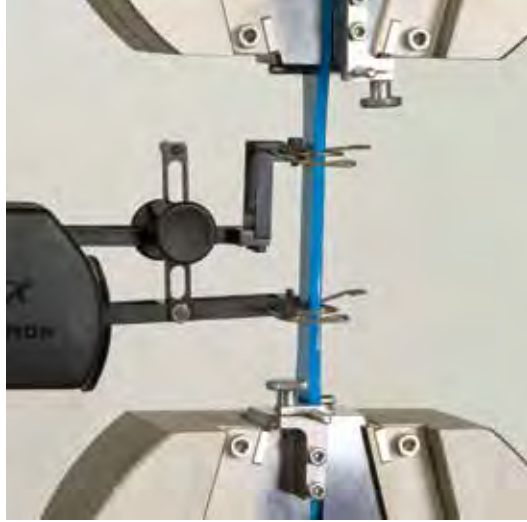




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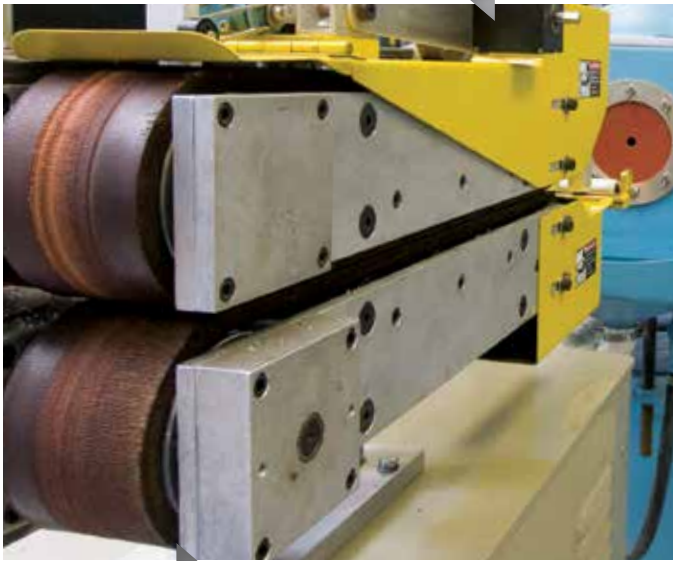
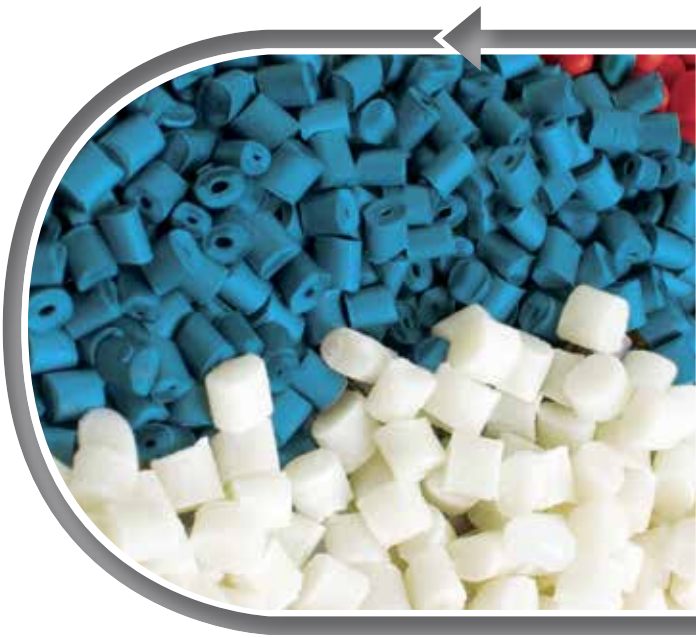
Plastics Testing Solutions



About Plastics Testing

Polymers are utilized in virtually every facet of human activity and industry including packaging, automotive, electronics, healthcare, construction, and aerospace. Characterization of the many properties of polymers is critical in developing and manufacturing these materials, ensuring quality control and determining the functionality of a finished product. It is important to understand the properties of a polymer as it moves through its life cycle, from raw material to compound, semi-finished and ultimately a finished product. Instron® offers a wide range of products tailored to address each and every critical need during the lifecycle of a plastic material.

The following pages document common testing challenges faced by our customers and how Instron solutions, suited to meet specific application needs, can solve them.



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Raw Materials Testing

A successful plastic product starts with choosing suitable raw materials and by setting up a controlled supply chain. Given a certain application, should a commodity polyethylene be used or some engineered polymer? What will be the right matrix for a composite? Are you equipped to assess the consistency of lots by one or more suppliers, and to predict and monitor critical aspects related to storage, processing, and final properties? Testing the flow properties of the granulated material, and preparing standard specimens for further mechanical and thermal tests, is the basis for Quality Control. The 'ID cards' or data sheets

of plastic materials are filled with data obtained by basic tests like melt flow rate, impact resistance (resilience), softening point, and tensile properties. When new products are developed, new formulations are tested and you need to check if the material can be processed easily, and determine the mechanical and thermal properties. Research and Development (R&D) requires a deeper insight based on the same types of tests routinely carried out for QC, but with a more versatile approach, a bigger amount of data collected and processed, and more sophisticated instrumentation to control the test.

In this section, you will see examples of challenges offered by the QC and R&D world of raw material testing on plastics and composites, and our solutions based on the range of Instron® products.

Flow Properties of Recycled Materials

The global trend towards increased recycling is encouraged by national and international regulations, and is creating both opportunities and challenges for the manufacturing industry. Bigger and bigger quantities of plastic scraps are available and ready for new melting and shaping into finished products. However, the quality of products may be inconsistent and ultimately the whole approach is inconvenient if the processing properties are not controlled. In some cases, it's necessary to determine a suitable amount of virgin material to mix with the recycled one.



Testing flow properties gives a good understanding of the processing behavior of recycled materials. The response of different batches and different blends can be checked with a basic Melt Flow Rate (MFR/MVR) determination by utilizing melt flow testers. Unknown and mixed materials - like those involved in recycling - require a variety of testing conditions, including several different test masses. CEASt MF20 and MF30 Melt Flow Testers can be equipped with the Manual Mass Selector, a device that holds a complete series of test masses and allows the user to select the most suitable one for each test. No handling of heavy weights or change in the instrument configuration are required. Further rheological characterization of materials can be performed by the CEASt SR Series of capillary rheometers.

Applicable Standards
ISO 1133, ISO 11443, ASTM D1238, ASTM D3835

The Challenge

Replacing Metal Alloys with Plastics

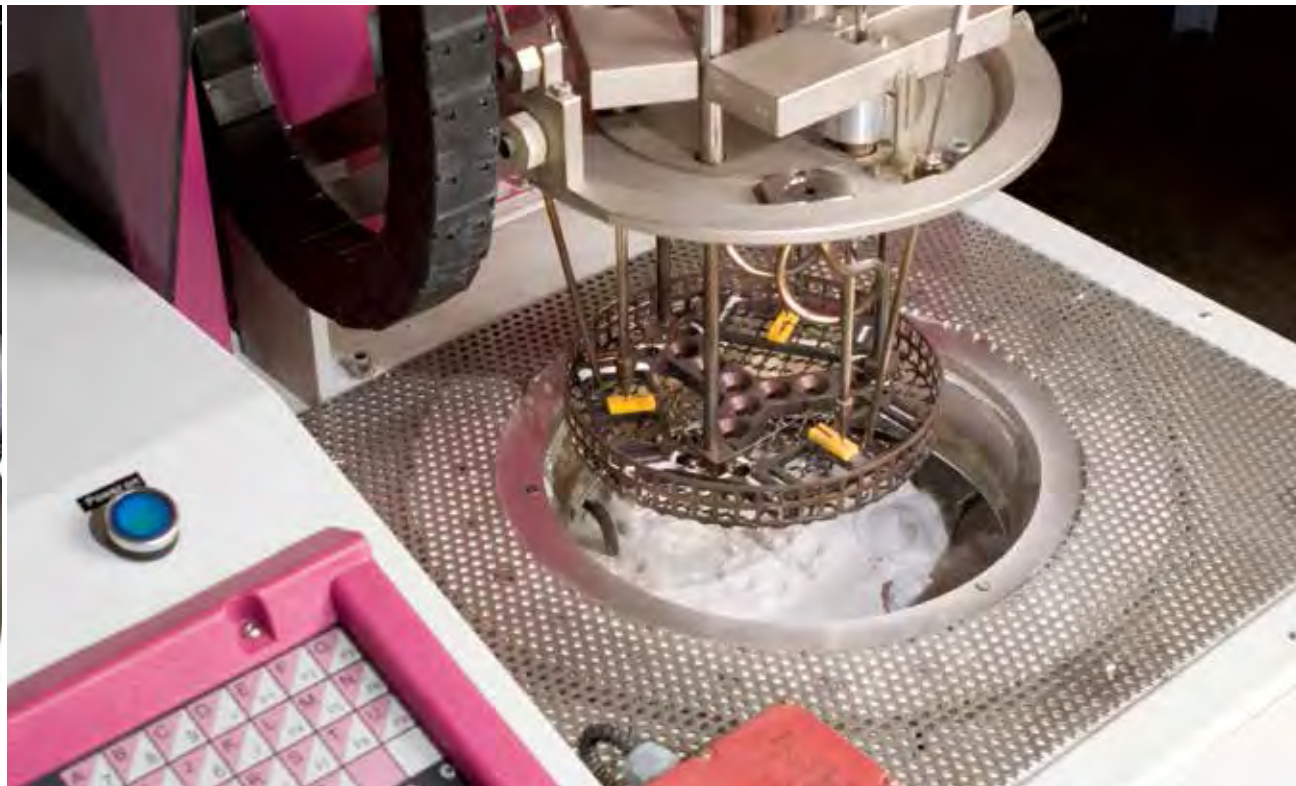
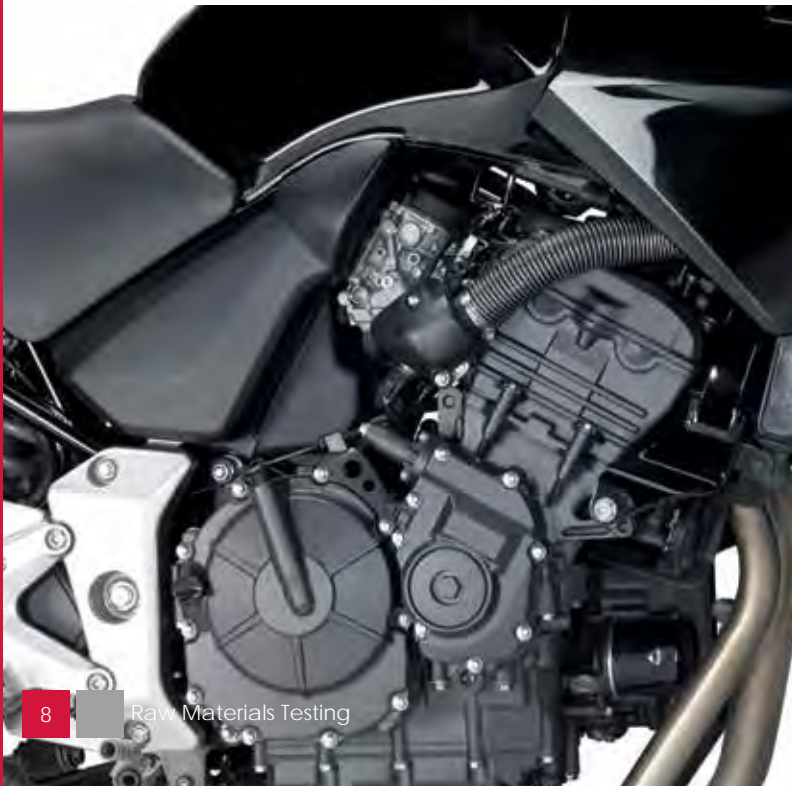
Ease of processing, reduced weight and cost, intrinsic chemical resistance: wherever possible, industry replaces metals with plastics – this challenging process is often referred to as metal replacement. Standard plastics have severe limitations in terms of maximum temperature and stiffness, whereas more advanced polymer materials have been developed and proposed for critical applications where they can successfully replace light metal alloys. Their outstanding thermo-mechanical properties need to be tested accurately to give engineers enough confidence and fundamental parameters for design.

Our Solution

HDT and Vicat (VST) are typical testing methods for assessing thermo-mechanical properties in a simple way, but normally have the same temperature limitations of the standard plastics they are applied to. For testing the most advanced plastics, we developed the CEAST HV500 high-temperature HDT/VST machine, which is based on a fluidized bath of inert ceramic powder instead of a standard oil bath. Its working range covers all plastics testing extending to as high as 500 °C. Thanks to its innovative principle, the CEAST HV500 reduces the interaction between heating medium and sample, and eliminates environmental concerns related to oil disposal.

Applicable Standards

ISO 75, ISO 306, ASTM D648, ASTM D1525



The Challenge

Multiple Melt Flow Testing Conditions in a Single Run



Quality Control (QC) tests, including monitoring of lot-to-lot consistency, are usually based on melt flow tests to evaluate the processing properties of materials. A basic Melt Mass-Flow Rate (MFR) or Melt Volume-Flow Rate (MVR) test with a single

standardized test condition is sometimes not enough to differentiate similar materials and to give a reliable characterization. While R&D can afford running more sophisticated tests, QC requires a large quantity of simple melt flow tests, but with the possibility of exploring different test conditions in a short time that extend beyond the capabilities of standard machines.

Effect of Fiber Reinforcement on Thermo-Mechanical Properties



The maximum temperature that a plastic can withstand while under load is a critical characteristic and a challenge that many manufacturers face. The performance of relatively standard materials can be enhanced dramatically by adding glass or carbon fiber; however, the amount

of reinforcing phase and its effectiveness needs to be determined and checked. Poor compatibility of the reinforcement and excessive cost increase must be avoided.

Our Solution



The CEAST MF50 tester performs melt flow tests applying several different load conditions in a single semi-automatic test. Values and sequence of test loads can be selected without changing the instrument configuration. The testing principle is the same as the standard MFR/MVR machines, but allows for higher productivity and comes with a state-of-the-art, user-friendly interface.

Applicable Standards
ISO 1133, ASTM D1238



When temperature is elevated, and a defined load is applied, Heat Deflection Temperature (HDT) tests offer a standardized and simple way to estimate the capability to retain mechanical properties. This applies significantly to the comparison of performances between unreinforced and reinforced materials. The CEAST HDT machines offer optimal temperature control accuracy and high resolution sensors to measure deflection, as well as offers the option for an advanced software interface. These machines can be used as QC tools and as a reference for more advanced R&D studies.

Applicable Standards
ISO 75, ASTM D648



Courtesy of University of Massachusetts, Lowell, USA

Process Optimization Testing

Even though a portfolio of materials and a processing technology is selected, engineers and technicians in the plastics industry still face big challenges. When they optimize a process they make it faster, cheaper, more accurate, more productive, and consistent with time. They need to handle known limitations of each process, including the onset of thermal degradation. The properties and quality of finished products are greatly affected. To achieve the desired improvements, a better knowledge of the behavior of materials under processing conditions is needed, and a series

of tests are required to sample the material at the different stages of the process. Pre-series finished products obtained from the process are also tested. Several processing parameters are consequently chosen and adjusted. Today, everyone wants to avoid running trial sessions with the real processing machines, which wastes energy, materials, and manpower. Simulations can run via software, but a reliable and comprehensive set of material data is required, which can be obtained due to suitable testing instruments.

In this section, you will see challenges in the field of process optimization and the tools offered by our products to give adequate solutions. Our goal is to support the job of qualified technicians and engineers of the plastics industry and related testing laboratories.

Evaluation of Thermal Degradation During Processing

One of the most common concerns over plastics processing is the degradation of the material caused by heat. This results in different chemical and structural properties, and eventually lower mechanical and physical properties of the final product. Higher temperatures are often sought when looking for increased productivity, but suitable dwelling times must be determined, and the effects on the material must be studied in detail.



Suitable testing procedures, aimed at verifying thermal degradation onset and effects, can be defined for both QC and R&D using CEAST Melt Flow Testers and CEAST Capillary Rheometers. Dedicated testing methods have been developed for our capillary rheometers to compare viscosity measurements performed at different times and temperatures. The CeastVIEW software assists you with data manipulation and reporting so you can understand the best working conditions for the process while organizing and presenting the most significant results.

Applicable Standards
ISO 1133, ISO 11443, ASTM D1238, ASTM D3835

The Challenge

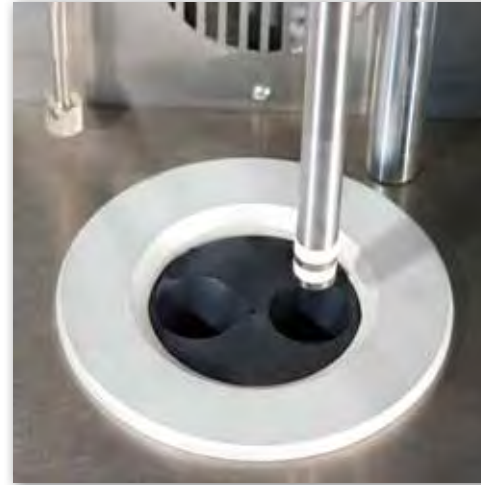
Data for Accurate Simulation of Injection Molding



Injection molding is a powerful processing technique with applications ranging from mass production of simple parts made of commodity plastics to sophisticated multi-material and in-mold decorated parts made of high value-added materials. To design the mold and define

optimal processing parameters, software simulations are employed with growing success, limiting the number of trials and related costs. However, accurate input data, including the relationship between pressure, specific volume and temperature known as the pVT diagram of the injected material under processing conditions.

Our Solution



Capillary rheometers allow for an extensive and comprehensive characterization of materials, representing the only off-line way to reproduce processing conditions. Dedicated accessories have been designed for CEAST Capillary Rheometers to measure the pVT of the melt under processing conditions according to ISO 17744. A single capillary rheometer, with its accessories, is capable of providing most of the information needed for an accurate process analysis and simulation.

Applicable Standards
ISO 11443, ISO 17744, ASTM D3835

Quantitative Analysis of Injected Parts

Injected parts may be affected by problems of homogeneity and consistency of the material and of their mechanical properties. This allows for unpredictable behavior and lower performance in general. Testing the finished product may be complex and not convenient. Even if specimens with a simplified geometry are prepared, visual inspection and other non-destructive tests are not enough to detect such problems. A quantitative analysis with a comparison to expected characteristics is necessary.



We recommend testing the impact resistance of plate/disc-shaped specimens with a drop tower instrument of suitable capacity. It's a quick test and makes it possible to rate the material in comparison with the behavior of known and well-performing materials. Testing a sample of only 5 - 10 specimens will demonstrate whether the properties are consistent and the process is properly set. Instrumented tests, with force sensors that are integrated in the striking tip and a high-frequency data acquisition system, allow for a detailed quantitative analysis including absorbed energy to failure, ductility index, and standard deviation of several parameters. It can also be completed by the visual inspection of the broken specimens.

Applicable Standards
ISO 6603-2, ASTM D3763, Industry/Customer Specific

The Challenge

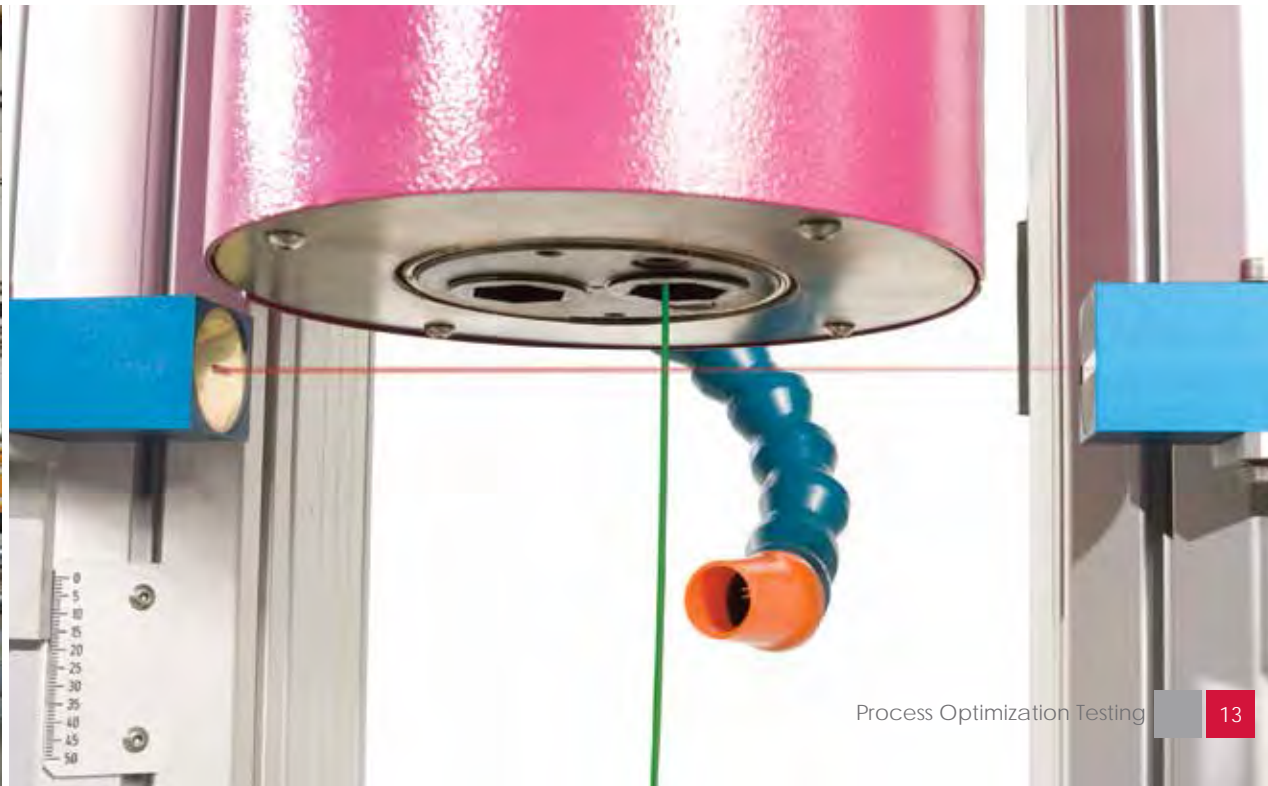
Optimizing Blow Molding and Extrusion Processing

When a polymer melt is extruded from a die, the cross-section of the extrudate is usually bigger than that of the die. This is called die swell and is related to the material's elasticity. The swelling can be related to processing problems and can generate defects in the finished product. The Die Swell device, equipped with a laser detector below the die exit, measures the diameter of the extrudate at different shear rates. The effect of swelling can be very strong, in particular with polyolefins (polyethylene, polypropylene) or very low polyamides and polycarbonate (polyesters).

Our Solution

CEAST Capillary Rheometers are designed for the complete characterization of materials like those used for extrusion and blow molding. The viscosity of materials can be accurately measured, and the optional die swell system effectively evaluates properties including swell ratio. These properties are especially critical for the blowing processes, since they represent the elasticity of the material at various temperature and processing conditions. The measure is performed by using a laser system placed below the capillary die, that measures the diameter of the extrudate.

Applicable Standards
ISO 11443, ASTM D3835





Mechanical Properties

Evaluating the mechanical properties of plastics is important to material engineers, designers, processing groups, and others within organizations that deal with plastics products. Mechanical properties, among other properties, are used for characterizing plastics and creating material specifications for different types of products. They are important in R&D and QC during the

evaluations of new materials and to ensure material performance doesn't change during production or over time. Instron® offers a variety of testing systems for evaluating these properties, some of which include universal, impact, dynamic fatigue, and hardness testing systems. These systems are used to test plastics to international standards, such as ASTM D638, as well as, other national and customer

specific standards. Some of the tests may include tensile, compression, flexural, fatigue, impact, hardness, and more.

In this section, you will see examples of challenges related to determination of various mechanical properties and our solutions based on the range of Instron products available.

Reproducibility Studies and Poisson's Ratio

Reproducibility studies have shown great variance in the measurement of Poisson's Ratio, revealing inconsistent results between labs, as well as within individual labs. Difficulty in measuring the ratio relates directly to the measurement of transverse and axial strain at very small strain ranges. It is entirely possible to measure Poisson's Ratio accurately when the correct equipment and procedures are utilized.



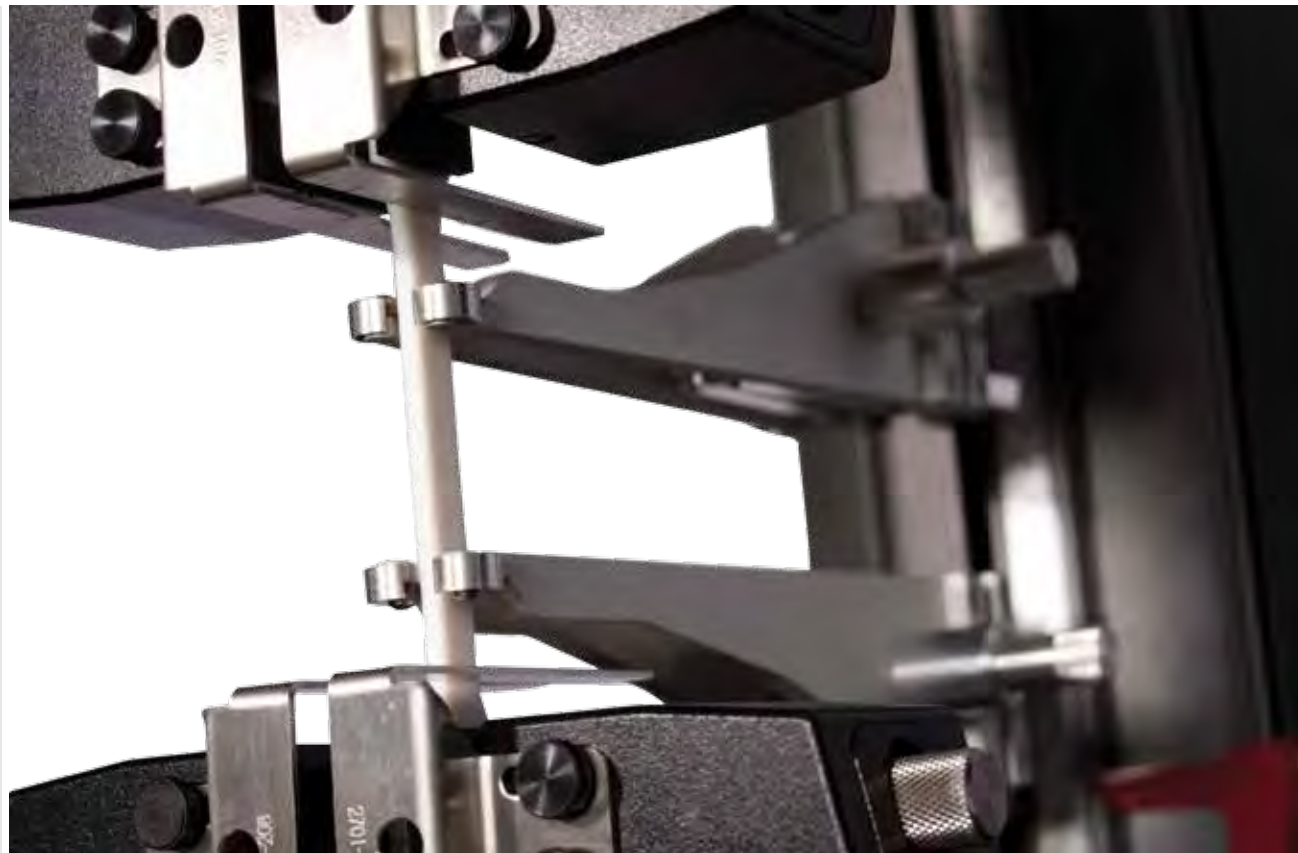
For most plastics, we recommend using a biaxial, high-resolution extensometer that measures both axial and transverse strain simultaneously. It is important to ensure that the appropriate grips and test methods are utilized. Pneumatic side-acting grips are preferred since they are self-aligning and permit adjustable clamping pressures. This allows for consistent clamping forces from one specimen to the next. Wedge style grips may work as well, but be cautious of moving jaw face wedge grips as opposed to moving wedge body grips. With moving jaw face style grips, specimens are susceptible to significant compressive loads prior to the start of the test. Compressive loads may cause the material to bow and in some cases even yield; both of which could impact the accuracy of the results.

Setting up an appropriate test method is also critical for achieving accurate and repeatable results. Studies have shown that a "preload" can improve repeatability of results by removing compressive loads applied during gripping and allow each test to begin at the same positive load or stress values. The preload value should be high enough that it will straighten a specimen without stretching it.

Applicable Standards
ISO 527-1,-2, ASTM D638, JIS K7162

Strain Measurement from Modulus to Break

For many plastics, particularly thermoplastics, it can be difficult to select an extensometer that is capable of accurately measuring modulus and strain at break. This is true for extensometers where accuracy is inversely proportional to travel and the strain at break is 50% or higher, which is common for many thermoplastics. Most tensile testing standards for plastics require direct strain measurement only up to yield and at that point, crosshead extension is acceptable. However, there are many labs interested in direct strain measurement at break.



There are several extensometer options available, some more suitable for particular situations than others. In the case of ASTM D638, the AutoX750 Automatic Contacting Extensometer, the Advanced Video Extensometer 2 (AVE 2), and some static clip-on extensometers are all acceptable solutions. When it is desired to measure strain to failure with an extensometer, the extensometer suitability is dependent on the amount of travel it can accommodate. Clip-on style extensometers have limited travel, usually 50%, when used to measure modulus, making them more suitable for rigid or filled plastics. The AutoX750 and AVE 2 can accommodate far more travel and are appropriate for semi-rigid, rigid as well as even elastomers. For ISO 527-2, we recommend the AutoX750, AVE 2, or some static clip-on extensometers. Similar to ASTM D638, if it is desired to measure strain through failure with the extensometer, the device must be able to accommodate the particular material being tested.

Applicable Standards
ISO 527-1,-2, ASTM D638, JIS K7162

The Challenge

Tensile Testing of Thin Films

Tensile testing thin films is one of the most common plastic tests, and more often than not, ASTM D882 or ISO 527-3 are the test standards followed. There are two common challenges that are encountered when tensile testing films. These include 1) instances when specimens fail at the grips and 2) uneven stress distributions. Both of these issues are strongly influenced by the grip type, type of jaw face, and specimen alignment. When the appropriate configuration is not utilized, repeatability and reproducibility of results will deteriorate and the data between labs, as well as between operators, will vary.

Our Solution



When testing films and the use of an extensometer is required, such as for ISO 527-3, it is crucial that the extensometer does not influence the results. We recommend either our automatic contacting extensometer (AutoX750) or our non-contacting extensometer (AVE 2). The AVE 2 does not physically contact the specimen and, therefore, does not influence the results or cause premature failure. The AutoX750 has measuring arms that are counterbalanced and operate on a nearly frictionless linear guidance system, making them virtually weightless. This feature removes any influence on the material's properties and will eliminate premature failure.

In addition to the testing equipment, specimen preparation is an extremely important factor to consider when evaluating the repeatability of results. Specimens with nicks, cuts, and non-parallel edges will impact repeatability. The CEAST Manual or Automatic Hollow Die Punch machines are ideal solutions for producing perfect specimens in a timely manner.

Applicable Standards
ISO 527-3, ASTM D882, JIS K7127



Automated Solution for Thin Films

Instron® developed a new automated handling system for tensile testing film and other flexible materials. The system utilizes a rotating carousel for specimen storage and a linear conveyor system that loads specimens from the carousel into the grips. Before loading into the grips, three thickness measurements can be automatically taken, averaged and entered into the software. By automating the measuring, loading, and testing of specimens, operators can be assured that optimum alignment and measurement is achieved for every specimen; thus improving the repeatability of results and increasing throughput.

The Challenge

Compression Testing and System Compliance

When conducting compression testing to ASTM D695, it is important to understand how system compliance and stiffness can impact results. Stiffness may vary considerably for the different frame capacities, as well as between manufacturers. When significantly high forces are expected, systems with inadequate frame stiffness are susceptible to absorbing energy from a specimen during testing and transferring it back into the specimen, resulting in a premature failure. Compliance or elastic “give” becomes more of an issue at lower forces and will typically occur within the load string. When compliance is not corrected or dealt with appropriately, load and extension data may not be entirely representative of the material being tested.

Tensile Testing in Non-Ambient Conditions

Most plastic products are expected to be used in various environmental conditions, some of which may include cold and hot temperatures. Since the mechanical properties of plastics are influenced by temperature, it is very important for designers to consider a plastic's performance over the temperature range a given product is expected to perform in. Environmental chambers are available to simulate both cold and hot temperatures. However, it is often challenging to identify the appropriate extensometers and fixtures to use at temperature extremes.

Our Solution



When stiffness is important, using an appropriate testing system is critical. Instron® 5900 universal systems are extremely stiff and offer significantly less frame compliance when compared to most other testing systems.

Stiffer testing frames will reduce system compliance, but for overall compliance, it is important to consider grips, fixtures, and adaptors. The most effective means of eliminating the affect of compliance on test results is by using a strain measuring device, such as an extensometer, which attaches directly to the specimen, or, a Linear Variable Differential Transducer (LVDT) that measures accurate displacement of the platens. If a strain measuring device cannot be used, it is possible to compensate for system compliance using Bluehill® Universal Software, which offers a load frame compliance correction calculation that can be applied to the test results.

Applicable Standards
ISO 604, ASTM D695, JIS K7181



The majority of our basic, standard, clip-on style extensometers are designed to work within a temperature range of -100 to 200 °C (-148 to 392 °F), which covers a vast range of the testing needs. However, there are some applications that have higher temperature requirements, for these application we recommend using our high-temperature clip-on extensometers, which can be used in temperatures as high as 600 °C (1112 °F). In addition to contacting solutions, video extensometers, such as the AVE 2, can also satisfy requirements for a variety of non-ambient applications. The AVE 2 can mount to the outside door of most Instron environmental chambers, allowing strain measurement through the viewing window without exposing it to the set-up's extreme temperatures.

Applicable Standards
ISO 527-1, 2, 3, ASTM D638, JIS K7162

Flexure Testing and Strain Measurement

Flexural strength and modulus are very important properties to plastics manufacturers since many parts are subjected to bending forces in their end-use applications. When following ASTM D790 for 3-point bend tests, extension taken from the moving crosshead is sufficient for calculating flexural strain. However, some standards, such as ISO 178, require either a direct strain source or corrected extension for determining strain.



If a direct strain source is being used, we recommend using a deflector, a spring-loaded plunger positioned below the specimen. When the specimen starts to flex, the plunger will compress and strain can be measured using an appropriate extensometer. The deflector is compatible with certain clip-on extensometers, the Advanced Video Extensometer (AVE 2), as well as the AutoX750 automatic contacting extensometer.

Applicable Standards
ISO 178, ASTM D790, JIS K7171

The Challenge

Increasing Throughput using Automated Specimen Handling Systems

When throughput requirements surpass output potential, laboratories face a difficult challenge and must figure out a way to increased throughput and efficiency. There are a few different paths laboratories can take. Operators could be encouraged to work overtime. While this could certainly increase daily output, overtime rates are typically much higher than standard rates so the increased output will come with a cost. Additionally, increased work hours are likely to tire employees, resulting in poor morale, lower quality work, and higher injury-related expenses. Another option may be to purchase more equipment and hire more operators. This would certainly be ideal but if testing volumes decrease there could be a lot of equipment downtime and inefficient use of manpower. A third option may be to operate a second shift (if applicable) and that would certainly increase daily throughput; however, more operators would need to be hired and additional expenses for running a laboratory for extended hours are likely to develop.

Impact Testing of PVC Vinyl Material



Homeowners looking to remodel the exterior of their house often turn to vinyl siding for its appearance, low maintenance and resistance to weather, and insects. Since consumers also value design flexibility, manufacturers must offer a portfolio of impact-resistant

styles. The siding needs to withstand accidental impact from tools and rough handling during installation. Over the lifetime of the house the product must be durable enough to resist rain, ice, and other weather-induced impacts, as well as sudden blows from objects such as lawn furniture, children's toys, balls, and rocks. Damaged panels and unrepaired cracks can propagate allowing penetration of insects and harmful moisture.

Our Solution



Fully-automated specimen handling systems allow for unattended testing throughout the day and evening shifts. These systems improve efficiency and reduce inaccurate data that may result from human error. Automated handling systems are designed to work with a range of sample sizes and geometries, so if throughput requirements drop drastically, minimal changes would be necessary to accommodate new samples. If desired, automated handling systems can easily be rolled away from a testing frame, allowing the frame to be operated manually.

Applicable Standards

ISO 178, ISO 527-1,-2, ISO 527-3,
ASTM D638, ASTM D882, ASTM D790, JIS K7162



A CEAST 9350 impact drop tower was configured to meet ASTM D4226, an industry specified test for identifying the energy required to fracture a specimen of PVC vinyl siding material. The Data Acquisition System (DAS) instrumentation package collects detailed data plots comparing the performance levels of vinyl panels with different surface textures and color additives. While the ASTM standard prescribes a nominal striker and support geometry, optional tools are developed to better simulate and study the effects of balls, rocks, and drills impacting the vinyl siding samples at various speeds and drop heights.

Moreover, PVC profiles can be punched in order to obtain specimens to be tested by means of pendulum instrument according to Charpy testing or tensile-impact tests according to different international standards.

Applicable Standards

ISO 179, ISO 8256, ASTM D4226

The Challenge

Penetration Resistance of Protective Body Armor



Standards for compliance testing related to the stab resistance of personal body armor determine the minimum performance requirements for the commercially available equipment. Based upon this testing method, the equipment's key

attributes are evaluated to ensure the suitable level of protection from sharply pointed instruments and weapons. The test results from justice agencies and technology organizations show that stab threats are by far the more difficult to defeat due to the contact characteristics, angle of incidence, and number of hits applied per armor.

Fatigue Tests on Plastics with a Temperature Chamber

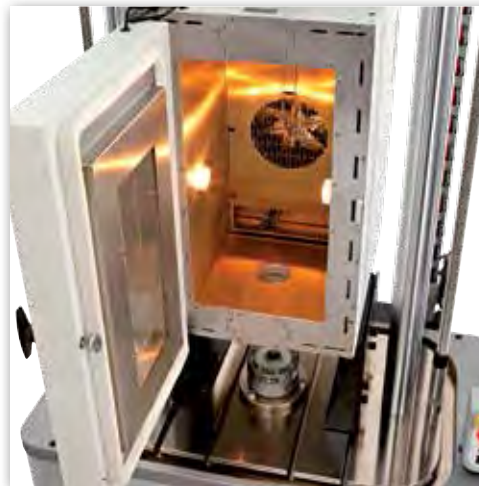
Plastics will fail at stress levels well below their tensile or compressive strengths when subjected to cyclic loading; they will fail more severely when subjected to a combination of tensile and compressive loads. Plastic materials are highly non-linear and demonstrate different properties when subjected to varying temperatures. It is important for designers to look at the characteristics and fatigue performance of these materials before incorporating them into their designs.

Our Solution



To test the stab resistance of personal body armor, we suggest a CEAST 9350 drop tower with a special setup that includes an instrumented tup equipped with a blade instead of a standard insert. This method specifies the minimum requirements for body armor designed to protect the torso against slash and stab threats. Penetration of the blade can be directly measured on the armor and compared with software calculations. It can be used for standard control according to standard or to study the performances of new materials and combinations.

Applicable Standards
NIJ 0115.00, Industry/Customer Specific



When performing low-force dynamic fatigue tests, we suggest using our ElectroPuls™ E1000 All-Electric Dynamic Test Instrument, in combination with a temperature chamber, to evaluate the performance of plastic materials at both low and high temperatures. We recommend using fatigue-rated mechanical or pneumatic wedge-action grips and pre-loaded push/pull rods. Wedge grips have adjustable clamping force which helps to ensure there is just enough pressure to grip the sample without slippage, while minimizing the risk of premature failure within the jaw face.

Additionally, WaveMatrix™ Dynamic Testing Software can automate the fatigue test with different stress levels on each step and integrated control of the temperature chamber. The optional Calculations Module allows real-time calculation of different material properties including: Dynamic Mechanical Analysis (DMA); Dynamic Stiffness (K^*) or Dynamic Modulus (E^*); Elastic Stiffness; and Energy. These properties help designers gain a better understanding of the visco-elastic response of the material under varying conditions.



Component Testing

Nearly everything you see has been tested during its development and manufacture. Component testing will continue to be an important aspect of product development and quality control. Advances in software and simulation tools have lowered the need to test some components during the earlier phases of development. More often than not, component testing continues to be a major requirement for OEMs at some point during the development and manufacturing of products.

Component testing includes simulation of loading conditions representative of potential and likely conditions a product may encounter when in use. An example would be to apply a constant load to plastic lumber with a 4-Point bend test over a period of time to measure creep. The test would be to ensure the plastic lumber will not permanently deform under the weight of a heavy object or other structure. Data generated from component tests could very well influence the design and material used in a product. For instance, if the plastic lumber were to permanently deform significantly, a designer

may decide to make the lumber thicker or find a different material with properties more appropriate for the application.

Component testing is also important in QC settings to ensure products coming off a line perform as expected. When out-of-spec products reach a customer, safety concerns and tarnished reputations can have serious implications on the well-being of a company.

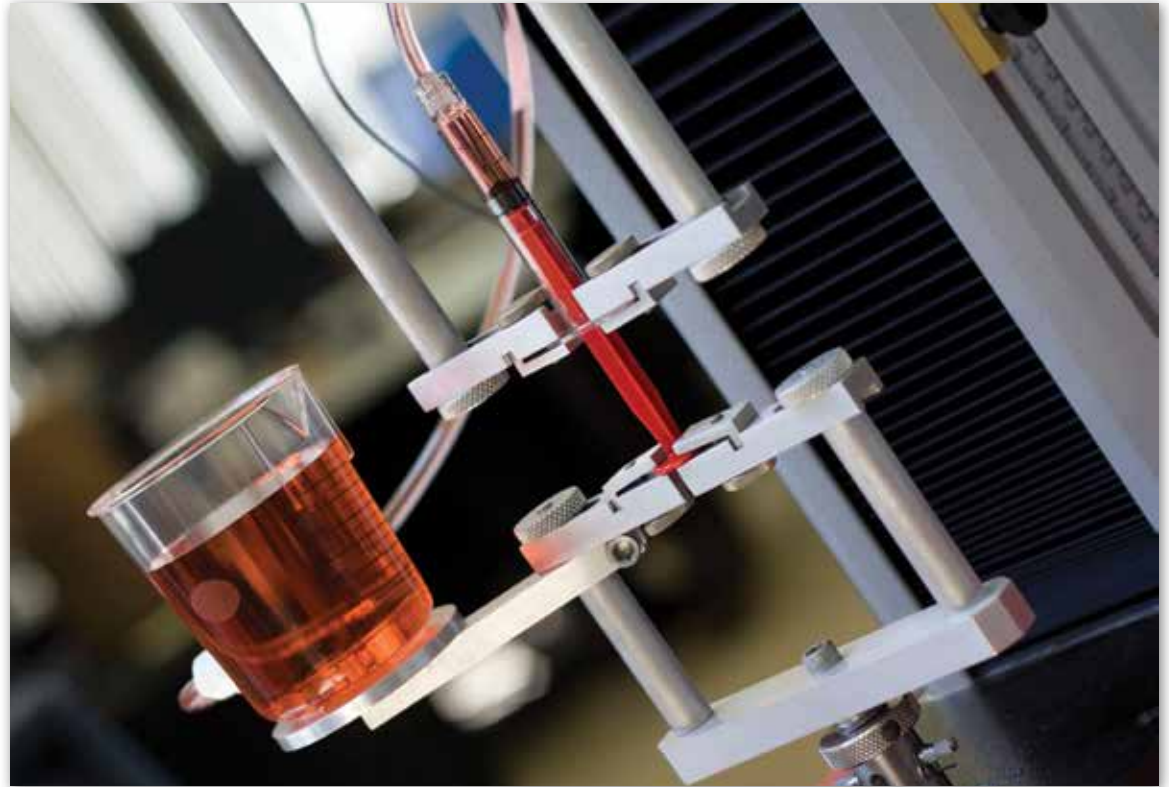
The Challenge

Force Measurement of Medical Syringe and Needle Devices

Syringes must be tested to ensure the forces necessary to move the plunger and eject fluid from the barrel are not too high or too low. These forces depend on many factors, including the device materials, viscosity of the liquid, radiation processes used for sterilization, and instrument design.



Our Solution



Our standard syringe fixture determines breakaway forces at the beginning of injections and sustaining forces throughout the injection process. Data is produced as the crosshead moves down to expel the fluid from the syringe in a compressive test mode. The test control and results are provided by Instron® Bluehill® Materials Testing Software. Initial, mean, maximum, and minimum forces can be calculated, reported or stored in industry-standard formats for further examination. When testing in accordance with ISO 7886-1 Annex G, we designed a fixture that allows for precise friction measurement for syringe plungers and the force measurements to eject medications from the syringe or the syringe/needle devices. The lower grip holds the barrel, while the upper unit is designed to eject liquid from the barrel in a compression test or inspire liquid into the barrel in a tensile test. Universal testing systems can be configured in either an upright or horizontal position to utilize these fixturing options. In some cases, the horizontal configuration is advantageous because it allows accurate simulation of the instrument in its functional position. This configuration may also prevent any sediment in the liquid from clogging the barrel or needle tip during the test.

Applicable Standards
ISO 7886-1, Industry/Customer Specific

Tensile Testing of Fishing Line



Tensile testing fishing line is becoming more and more challenging as top producers, like Zebco, improve the performance of their products, creating stronger lines that are smaller in size. Tougher products often create difficulty associated with jaw breaks and specimen slippage.



We offer several different types of grips that utilize a capstan style design. This is necessary to distribute the stress over a larger portion of the grip surface - reducing the chances of a jaw break. For most fishing lines, the standard cord and yarn grips are sufficient; however, there are some products that are tougher to test and require a more specialized solution. For these types of products, which are often high strength and low friction, we recommend our Aramid cord and yarn grips. The Aramid grips have a higher clamping force but more importantly, a different type of surface finish that is designed to reduce jaw breaks.

Applicable Standards
Industry/Customer Specific

Crack Resistance of Automobile Bumpers



Impact testing on plastic components used in cars and motorcycles provides data about their response to an impulsive high-speed mechanical impact and invaluable information in regards to safety. One example comes from studies completed by automotive companies on

vehicle bumpers. To absorb a mechanical impact, such as an unintentional bump at low speed, bumpers must deform in a flexible manner. However, at the same time, they must have the ability to break and dissipate part of the impact energy during a major incident. These qualities must be determined for different working temperatures and conditions.



To understand the impact resistance properties of the material used in the bumper, we recommend performing a series of tests on specimens - in plaque form - at varying impact energies, velocities, and temperatures. After collecting this data on the raw material, the finished bumper can then be tested under the same set of conditions. By fully instrumenting the test with a tup and data acquisition system we are able to evaluate how the bumper reacts to an impact event by studying the changes in the load-deformation curves from the varying test events.

Applicable Standards
Industry/Customer Specific

The Challenge

Impact Resistance of Soccer Shoe Soles



One of the most common sports played around the world is football (American soccer). An important piece of equipment that the player wears is their shoes, giving them the best support, stability, grip, and traction necessary. Furthermore, the type of sole, which is the most strategic component of the shoe, will

strongly depend on the field and the weather conditions. With such a great investment in research and development to correctly design and shape the lower surface, the material to be adopted is highly important and plastic is playing a dominant role in this market.

Eyewear Products and Impact Performance



A significant portion of the world's population wears some form of corrective or protective eyewear such as reading glasses, sunglasses or sports goggles. Eyeglass lenses made from plastic are lighter in weight and more comfortable to wear. If impacted, lenses must not allow significant pieces of the

material to break off the surface closest to the eye. The primary purpose of eyewear is to improve vision, but the lenses must also withstand impact forces resulting from unintentional drops and hits. The potential consequences of impact failure are immediate and severe. Government regulations set minimum impact performance standards for eyewear products. These often outline simple tests including dropping a steel ball of a required size and weight from a defined height onto the lens.

Our Solution



Manufacturers need a flexible system to evaluate the impact resistance of raw materials, as well as the end-product. The CEAST 9300 Drop Tower series is versatile enough to guarantee the test of the raw material, as well as testing the finished soles of the shoes at different impact energies and speeds. Using a multi-purpose plate allows the accessory to be placed in the correct test position. We suggest using interchangeable tup inserts of different shapes and sizes to simulate the effect of an impact on the lower surface during rushes, runs, jumps, and accelerations. These inserts can be used in combination with an instrumented tup and a Data Acquisition System (DAS) to gather impact results.

Applicable Standards
Industry/Customer Specific



Lens manufacturers need a flexible test instrument to research materials and demonstrate product compliance to government specifications. We designed a custom support fixture and mounted it in the lower test area of the CEAST 9310. During this test, we impacted different materials with various coatings at multiple drop heights. The data provided detailed information about the relative deflection, maximum load, and energy absorption of the different materials and coatings. This information was used to steer product development and to demonstrate product compliance.

Applicable Standards
FDA Title 21 Sec. 801.410(d)(2)

Durability of Handheld Electronic Devices

Many consumer electronic products ranging from mobile phones and cameras to game controllers and MP3 players are subject to a variety of arduous conditions during everyday use. Repetitive operational forces, along with accidental damage caused by drops, bumps, and other misuses, cause damage to plastic casings, lens covers, keypads, and buttons. Cumulative effects can result in a buildup of microscopic damage that may eventually result in failure of a piece part and render the device inoperable.

With the widespread use of handheld electronic devices in the marketplace and the growing dependence our population places in them, it is becoming more unacceptable to consumers for these electronic products to fail during a reasonable product life. As the feature gap between many products narrow and with increased competitiveness of many devices in the market, differentiators such as quality, robustness, and durability of these consumer products can be advantageous to many manufacturers.



The Instron 5944 with XY stage is designed to perform multi-point compression testing on plastic components such as buttons. The XY stage offers the ability to load multiple samples or components and conduct low force compression testing on all the samples in one single automated run. This test is primarily performed to record low deflection of the components and typically measures the stiffness of various samples.

Instron's Bluehill® 3 with multi-test feature offers user friendly approach to create methods.



For testing the materials used to make game controllers we recommend using either the 9350 or the 9340 Tester with Data Acquisition System (DAS) and Visual Impact software, configured to meet ASTM D3763 and/or ISO 6603-2. With either of these systems the test can be set up to replicate a drop that the controllers may be subjected to during their life. A custom fixture allows the controller to be impacted in several locations that are important to the controller surviving the impact. The impact resistance information gathered by performing instrumented testing can be used to help determine the best material and manufacturing process for the casing, as well as making improvements to the overall design.

The Challenge

Impact Resistance of Thermoplastic Pipes and Fittings



The impact resistance of thermoplastic pipes and fittings relates to its suitability for service and to the quality of the processing. It may also provide a relative measure of the material resistance during handling, installation, and in non-buried applications, to in-service breakage. ASTM D2444

determines the resistance of thermoplastic pipes and fittings to impact by a falling dart (tup) under defined conditions. Results gathered can be used for establishing impact test requirements in product standards and to measure the effect of changes in materials, processing, and any effects of the environment on the pipes or fittings. A valuable piece of information that may not be found without the use of testing systems is the first crack or incipient damage point. Pipes or fittings may fail in interior areas and remain undetected when visually inspected.

Evaluating Fatigue Behavior and Performance of Athletic Shoes



During the design and development of the latest sports shoes, engineers and researchers need to investigate the impact and rebound performance of different materials and sole designs. In addition to normal everyday uses, high-intensity sports activities such as

basketball, skateboarding, or running are placing even more challenging demands on today's athletic footwear that can result in impact forces at more than 10 times the bodyweight. Manufacturers are under pressure to develop new sports shoe designs with advanced air cushioning, gel-filled capsules, and complex sole structures that offer superior technical performance.

Our Solution



When testing only to the lower impact energies (12 to 60 ft-lb), we recommend using the CEAST 9340. If the product needs the maximum test conditions (300 ft-lbs), the CEAST 9350 with the High Energy Option is ideal. Smaller pipes and fittings can be easily tested on either system. To prevent a secondary impact of the falling weight onto the pipe or fitting, our anti-rebound device is ideal. The large area at the bottom of the testing systems offers room for larger diameter pipes up to 12 inches. For pipes wider than 12 inches, we offer larger, extended support tables.

Additionally, to fully protect the operator from flying debris, we include a selection of interlocked safety enclosures. Lastly, by including the instrumentation package, the operator is able to find and gather detailed data collection of failure points.

The CEAST 9050 impact pendulum is ideal for other tests according to ISO standards. These tests allow the operator to determine the impact strength of a thermoplastic pipe by the Charpy method. A short length of pipe, or a strip test sample, is conditioned at a selected temperature and then supported by a horizontal beam, unnotched, and promptly struck once on a line midway between the supports by a pendulum with a given energy (typically 15 or 50 J). After the impact, it is necessary to inspect the test piece for damage and to report the number and the percentage of failures in respect to the total amount of specimens tested.

Applicable Standards
ISO 7628, ISO 9854, ASTM D2444



In addition to performing mechanical tests to ASTM F1614, our ElectroPuls® Test Instruments provide flexibility to test other criteria - including the evaluation of energy returned by a shoe during impact, the amount of cushioning provided by different shoe and sole designs, and the long-term fatigue behavior of the shoe.

WaveMatrix™ Dynamic Test Software's optional Advanced Control Module provides the ability to ensure cross-mode peak levels are maintained on impulse and other complex profiles such as walk cycles or recorded gait data. The calculation of properties such as Energy, Elastic Stiffness, and Dynamic Mechanical Analysis (DMA) help characterize the shoe's performance.

Applicable Standards
ASTM F1614



Packaging Testing

Packaging materials play a critical role in the global market. Food, consumer goods, healthcare products, toys, and electronics rely heavily on advances and developments occurring in the packaging industry. A package's key function is to protect its contents from damage caused by improper handling, environmental factors, or bacteria. The demand for improved materials and innovative types of packaging is ever-increasing. For some products, faulty or inappropriate packaging may result in serious implications for

the producer as well as for the end user. Products such as disposable medical devices, must be sterilized prior to use. To ensure sterilization during shipment and storage at the customer sites, appropriate packaging must be used. For the food industry, packaging is a leading concern not only due to the growing number of food products on the market, but the consequences of contamination within the global food chain are enormous.

Tensile, seal, burst, and flexural strengths are just some of the many properties that are important

for packaging applications, all of which can be determined using a universal testing system. Puncture tests can be performed with a drop tower that utilizes a variety of clamping and striker geometries. Tensile impact tests can also be carried out with pendulum machines.

In this section, you will see examples of challenges related to various packaging applications and our solutions based on the range of Instron® products.

The Challenge

Impact Testing of Plastic Storage Containers

Reusable plastic containers - sold in a wide range of shapes, sizes, and colors - are popular for preparing and storing food. Designed for use in refrigerators, freezers, microwave ovens, and dishwashers, these versatile containers must withstand harsh temperature extremes without deterioration. Cold containers can easily crack or split when dropped; hot containers can become too soft and easily separate from a lid. In either case, the resulting food spills or contamination leads to consumer frustration. Key for the provider of these containers is how to strengthen the impact resistance while maintaining costs associated with their production.



Our Solution



Impact testing needs to be performed on materials in both raw and finished states, and allows the producer to determine the best mix of material components - raw to regrind mix and resin to resin - by comparing resistance to impact tests. Testing finished products allows the customer to analyze design impact (knit line locations, overall design/shape), and manufacturing process. Using a CEAST 9340 or 9350 Impact System - configured with lighter weight crossheads and anti-rebound devices - customers can look for and find incipient crack damage. Lastly, the addition of an environmental chamber allows for heating and cooling of specimens for further testing and evaluation.

Applicable Standards
ISO 6603-2, ASTM D3763, Industry/Customer Specific

Tear and Puncture Resistance of Plastic Films



Plastic films used in packaging are subjected to impacts during the filling process or subsequent stages. If the packaging tears or punctures, the product packed within may become tainted. The packaging market is growing around the world and the demand of new and sophisticated

material is a priority. From one side, the market is asking for the improvement of the typical behavior and on the other side, there is a growing interest in the new and innovative aspects. One aspect that seems to interest the global market is the possibility to substitute synthetic materials with those obtained from renewable resources (biopolymers).

Impact Resistance of Milk Bags



Milk is one of the most popular beverages around the world and is the primary source of nutrition often consumed outside the home. The increasing need to distribute, transport, and store milk bags, which minimizes the production costs, is one essential element of the packaging producers. Due to this request,

all operations are done in a manual process and the milk bags are often manually moved and distributed. One of the biggest challenges for bag producers is developing advanced technologies that reduce costs and increase impact resistance of the milk bags that may be subject to impacts during these manual movements.



Thin films can be tested by means of many different methods, according to the aspect of the film under investigation. For puncture resistance a drop tower system or ball drop tester should be used, and the tear resistance can be measured with tear tester (Elmendorf Pendulum). In addition, the drop tower should be used in combination with an instrumented tup, which allows for additional analysis and comparisons on the tested film. For example, the failure of layered structures in the penetration test may be characterized by a variety of changes in the load-displacement curve after first crack or damage. In addition, some of the most common films show multiple peaks or multiple slope changes when testing a layered, or filled material.

Applicable Standards
ISO 7765-2, ASTM D7192,
ASTM D5420, ASTM D1709, ASTM D1922



The milk bag is placed on the flat support and a tup, instrumented or not, is released with a predefined energy per the testing standard. A flat surface insert will impact the bag, causing the milk bag to compress. By following this process, quality professionals can verify the impact resistance of the bag. The instrumented tup captures the force of impact onto the bag - allowing users to evaluate the failure force and the energy that is necessary to break the bag.

Applicable Standards
ASTM D7192, ASTM D5420, ASTM D1709, ASTM D1922

The Challenge

Adhesive Strength of Medical Packaging

The medical device industry is moving toward pre-packaged disposable devices, such as surgical instruments and syringes. The tensile strength of the adhesives used for such packaging must be assessed according to ASTM F88 to ensure sterilization of the instruments during shipment and storage at the customer site.



Our Solution



Tear, Peel, Friction (TPF) software module contains pre-configured methods for conducting three different peel tests: T-peel, 90° peel, and 180° peel. Using a high-data acquisition rate to ensure the peel profile is accurately characterized, the strength of the adhesive bond is evaluated using the basic calculation of maximum force on an absolute peak, or using more advanced calculations such as the average of a specific number of peaks, troughs or a combination of both. Users have great flexibility in specifying where measurement begins and ends, enabling the software to calculate a broad range of results.

Applicable Standards
ASTM D903, ASTM F88, JIS K6854-2



Impact Testing Systems

Impact tests expose materials and products to dynamic events, forcing the material to absorb loads quickly. The information provided by this type of testing is useful in understanding how that material will perform in real-life situations. The purpose of impact testing is to simulate these real-life conditions in an effort to prevent the product from breaking, or to make its failure predictable. While all impact tests measure the absorbed energy when defined stresses are applied at various speeds, there are significant differences in equipment, specimen geometry, and results interpretation. The common impact test methods can be divided into two categories: (1) impact by a swinging pendulum or (2) impact by a falling dart.

Capillary Rheometers

The innovative SmartRHEO Series of Capillary Rheometer systems accurately investigate the rheological properties of polymers and composite thermoplastic materials for R&D, Advanced QC, and process optimization- including injection molding, extrusion, and blow molding. A broad range of options simulate specific applications and include fundamental properties like Melt Strength, Thermal Conductivity, Die Swell, and PVT.



Melt Flow Testers

The versatile Melt Flow Tester Series are ideal for routine Melt Mass-Flow Rate (MFR) and Melt Volume-Flow Rate (MVR) measurements. These testers accurately perform test procedures ranging from the simple manual determination of MFR to semi-automated MVR measurements involving multiple test weights.



Thermal Testing

From very simple units for quality control labs to more advanced and automated systems, the Instron® line of CEAST Thermal systems are designed to determine the behavior of plastic materials at high temperatures. They measure the heat deflection temperature (HDT) and the Vicat softening temperature (VST) according to the related ISO and ASTM international standards. CEAST HDT and Vicat testers are equipped with either 3 or 6 independent working stations that automatically run the entire test cycle. Part of this testing application series is the innovative Aloxide tester using the Aluminum Oxide micrometer-sized powder heating system.



Specimen Preparation

According to the requirements of international standards, Instron offers an extensive range of machines designed to cut out specimens from thin and soft plastic materials. Manual and fully-automatic notching, milling, and punching cut methods cover the widest range of testing applications.



Bluehill® Universal

Bluehill Universal is our newest static testing software, built from the ground-up for touch interaction. The new portrait layout, with its meticulously crafted visual design, gives the most comprehensive view of the test workspace on the Operator Dashboard, a stunning large-format touch monitor with an integrated controller. Bluehill Universal's large touchpoints and intuitive gestures make the user experience simpler and smarter. While maintaining all of the power and flexibility found in previous versions of Bluehill Software, Bluehill Universal boasts many advanced capabilities, such as pre-loaded test methods, QuickTest in seconds, and enhanced data exporting.

5900 Series

The 5900 Series offers exceptional performance and is designed with enhancements that deliver superior accuracy and reliability. Systems range from single column frames, capable of low-force testing below 0.5 kN, to heavy duty floor model systems capable of testing forces up to 600 kN. 5900 Series frames are most commonly used for tensile and compression testing. Additional test types include tension/torsion, shear, flexure, peel, tear, friction, cyclic, and bend tests.



3300 Series

The 3300 Series of mechanical testing systems are ideal for routine tests, providing simplicity and performance. System capacities range from <0.5 kN up to 100 kN and can be configured for operation with Bluehill LE and Bluehill Universal Software.

Dynamic Testing Instruments

This extensive range of fully-integrated dynamic and fatigue testing systems are capable of running tests from 1 N up to 2500 kN. Incorporating servohydraulic, servo-electric, and linear motor technologies, these test instruments cover a broad range of fatigue, dynamic, and static testing applications. These applications include high-cycle fatigue, low-cycle fatigue, and thermo-mechanical fatigue, crack propagation and growth studies, fracture toughness, bi-axial, axial-torsional, multi-axial, high strain rate, quasi-static, creep, stress-relaxation, and other types of dynamic and static tests.



AT2 XY Stage

The Instron® Automated XY Stage Testing System is designed for automated compression or tension testing of devices and/or components with multiple and repetitive test points via a motorized XY Stage. The XY stage easily mounts to a 5940 series single column testing frame and Instron's TestMaster Automation Control Software provides simple configurability to meet a variety of testing needs.



Multi-Station Test Frame

The Instron 5900 Series Multi-Station System offers enhanced throughput with its ability to perform simultaneous, independent tests on up to five (5) separate specimens using a single load frame. Based on our standard 5967 testing frame (30kN capacity), this system is especially suitable when expected test times are lengthened due to high elongation or slow test speeds.



TestMaster AT3 and AT3+

The Instron TestMaster AT3 (tensile) and AT3+ (flex) Automated Testing System utilizes an innovative design for the automatic tensile and/or flexural testing of plastic specimens. Meeting the testing requirements of ASTM D638 and D790, ISO 527-2 and ISO 178, the automated specimen loading feature improves repeatability and reproducibility of testing and results.

The many standards referenced within this brochure are not intended to be a complete and comprehensive worldwide list of standards; but a list of the most prominent and widely-used in the materials testing industry. Many of the testing solutions discussed are closely related to standards defined by other national, international, and industry-specific standards organizations. For further information, support, or application expertise, please contact your local Instron® office. We also encourage you to visit the Testing Solutions section of our website at www.instron.com

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*To learn more about our solution for this standard, please visit the Testing Solutions section of www.instron.com

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Support for the Life of Your Equipment



When You Need Us, We're There

Founded in 1946, Instron® has established itself as a leading supplier of materials testing equipment and solutions. Operating with 25 offices in 18 countries and more than 1200 employees, we have a global infrastructure that is local to you and remain committed to advancing materials and components testing techniques.



Maximize Uptime

The Instron world-class service organization is committed to deliver high-quality installation, calibration, training, maintenance, and technical support throughout the life of your system. We help ensure that your systems are there when you need them.



Quality Standards You Can Trust

Operating under ISO 9001 quality standards and with an extensive list of accreditations, Instron employs a product design philosophy where our customers' data integrity, safety, and protection of investment are paramount. We strive to ensure that our customer satisfaction is second to none.

Americas

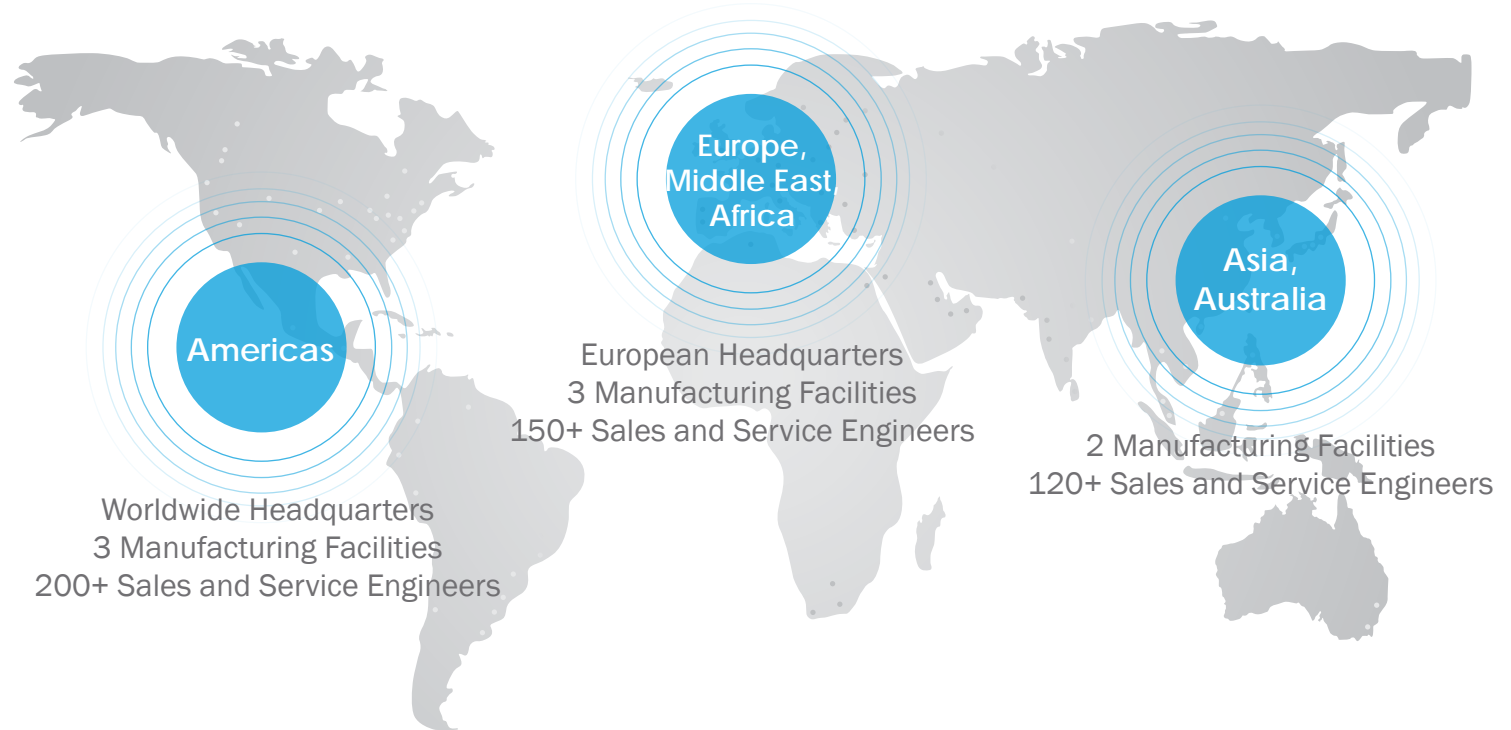
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