About Plastics Testing

Characterization of polymer properties is critical in the development and manufacturing processes of materials, as well as the quality control and in determining the functionality of a finished product. Polymers are utilized in virtually every facet of human activity and industry - from packaging to automotive, electronics to healthcare, and construction to aerospace. Understanding these properties is critical as a polymer material moves through its life cycle of raw material → compound→ semi-finished → finished product. The wide range of Instron® product offerings are tailored to address each and every critical area during the lifecycle of a plastic material.

Following are challenges faced by our customers and how we incorporated solutions that suited their specific applications.
Raw Materials Testing
- Flow Properties of Recycled Materials, p7
- Replacing Metal Alloys with Plastics, p8
- Multiple Melt Flow Testing Conditions in a Single Run, p9
- Effect of Fiber Reinforcement on Thermo-Mechanical Properties, p9

Process Optimization Testing
- Evaluation of Thermal Degradation During Processing, p11
- Data for Accurate Simulation of Injection Molding, p12
- Quantitative Analysis of Injected Parts, p12
- Engineering Multi-Layer Films for Optimal Performance, p13

Mechanical Properties
- Reproducibility Studies and Poisson's Ratio, p15
- Strain Measurement from Modulus to Break, p16
- Tensile Testing of Thin Films, p17
- Compression Testing and System Compliance, p18
- Flexure Testing and Strain Measurement, p18
- Shore® Hardness Testing, p19
- Tensile Testing in Non-Ambient Conditions, p19
- Increasing Throughput using Automated Specimen Handling Systems, p20
- Impact Testing of PVC Vinyl Material, p20
- Penetration Resistance of Protective Body Armor, p21
- Fatigue Tests on Plastics with a Temperature Chamber, p21
Component Testing

Force Measurement of Medical Syringe and Needle Devices, p23
Tensile Testing of Fishing Line, p24
Crack Resistance of Automobile Bumpers, p24
Personal Protective Equipment Testing, p25
Eyewear Products and Impact Performance, p25
Durability of Handheld Electronic Devices, p26
Impact Resistance of Thermoplastic Pipes and Fittings, p27
Evaluating Fatigue Behavior and Performance of Athletic Shoes, p27

Packaging Testing

Impact Testing of Plastic Storage Containers, p29
Tear and Puncture Resistance of Plastic Films, p30
Impact Resistance of Milk Bags, p30
Adhesive Strength of Medical Packaging, p31
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 CEAST Melt Flow testing machines. It can also be researched by means of a complete rheological characterization performed by capillary rheometers. CEAST Smart Rheo capillary rheometers evaluate viscosity properties over a wide range of conditions, plus additional characteristics of the sample including thermal degradation, shear sensitivity, viscosity dependence on temperature, melt instability, and die swell. Eventually, the recycled material becomes a known material that can be conveniently used.

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

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 Aloxide 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 Aloxide 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 7028 Multi-Weight 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

Raw Materials 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
Applicable Standards
ISO 11443, ISO 17744, ASTM D3835, ASTM D5930

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 Thermal Conductivity of the melt under processing conditions according to ASTM D5930, and pvT diagrams can also be obtained. 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, ASTM D5930

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 tup 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
Engineering Multi-Layer Films for Optimal Performance

Blown films can be engineered to give optimal properties due to multiple layers extruded at the same time. Each layer has a different formulation, but needs to be compatible with the neighboring ones and give a specific contribution to the overall performance of the film. Feasibility and productivity of the process relies upon the processing properties of each layer and the consistency of such properties. Mechanical and chemical properties of the finished product depend on the fine tuning of processing parameters.

Our Solution

CEAST Capillary Rheometers are designed for the complete characterization of materials like those used for film blowing. The viscosity of materials composing each layer can be accurately measured, and the optional melt stretching unit effectively evaluates properties including melt strength and maximum drawing speed. These properties are especially critical for the blowing processes, since they represent the response of the material to high mechanical stresses while cooling. Finally, you can compare the results obtained from different formulations and determine the best choice, based on the feedback from the process and the characterization of the finished film.

Applicable Standards
ISO 11443, ISO 16790, ASTM D3835
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 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 bi-axial, 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 people interested in direct strain measurement at break.

For operators that remove the extensometer at yield or test materials that strain less than 50%, traditional clip-on style extensometers are highly recommended. For operators testing higher elongation materials to failure, we have two recommendations. For non-contacting measurement, the Advanced Video Extensometer (AVE) is an excellent choice, offering higher accuracy and more travel than most traditional clip-on style extensometers. Also, because the AVE is non-contacting, there is no influence on the test specimen and no possibility of damage due to energy release at failure. For contacting solutions, we recommend our Automatic Contacting Extensometer. The Automatic Contacting Extensometer is a high-resolution extensometer with 500 mm of travel. The measuring arms are counterbalanced and operate on a nearly frictionless linear guidance system, making them virtually weightless while removing any influence on the material’s properties.

Applicable Standards
ISO 527-1,-2, ASTM D638, JIS K7162
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. By automating the loading of specimens, operators can be assured that optimum alignment is achieved for every specimen; thus improving the repeatability of results.

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.

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
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.

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. Traditionally, for 3-point bend tests, extension taken from the moving crosshead has been sufficient for calculating flexural strain. However, some standards and companies require a direct strain source for the determination of strain.

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 would be attached directly to the specimen or a Linear Variable Differential Transducer (LVDT), which measures accurate displacement of the platens. If a strain measuring device cannot be used, it is possible to compensate for system compliance using Bluehill® 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

For this requirement, the use of a deflectometer is required. Most flexure fixtures are designed to accommodate a deflectometer or other deflection measuring devices. For the 2810-400 fixture, all that is required to measure direct strain is a deflectometer or a spring plunger and an appropriate clip-on style extensometer. The AVE may also be used to measure direct strain off a deflectometer.

Applicable Standards
ISO 178, ASTM D790, JIS K7171
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, and for these applications, we recommend our high-temperature clip-on extensometers, which can be used in temperatures as high as 540° C (1004° F).

In addition to contacting solutions, video extensometers, such as the AVE, can also satisfy requirements for a variety of hot and cold applications. The AVE can mount to the outside door of most Instron® environmental chambers, allowing it to measure strain through the viewing window while not subjecting it to the various temperature extremes.

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

Shore® Hardness Testing
Most manufacturers of rigid thermoplastics, such as polypropylene and plexiglas, fiberglass reinforced resins, and epoxy curing agents, need to verify the hardness of cured products. Accuracy and efficiency become critical factors when testing samples that can transition across scales, variations on geometry, specimen thickness, and hardness values. Comparisons between vendor and end-user are common place, and variables contributing to erroneous readings must be eliminated wherever possible.

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.

Applicable Standards
ISO 7619, ASTM D2240, DIN 53505

As with all durometer testing, it is imperative to maintain 90° specimen to indenter perpendicularity while sustaining the appropriate force application pressures throughout the entire testing cycle. The Shore 902 Series Automatic Operating Stands ensure both constant force application and specimen alignment by means of a motorized, electronically controlled testing and braking apparatus. Compatible with our Shore S1 digital type durometers of various scales, the Shore 902 Automatic Operating stand offers increased throughput and improved measurement accuracy and repeatability with this simplified “hands-free” operation. The digital readout (0.1 resolution), data storage capability, and ease-of-use ensure the most accurate and versatile instrument available today.

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

Mechanical Properties
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 unrepaird 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
Applicable Standards
NIJ 0115.00, Industry/Customer Specific

Mechanical Properties

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.

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.

To verify the protection level of the armor, we suggest utilizing an instrumented striker, equipped with a standard defined blade that is attached to a standard carriage. The impacting energy, mass, and speed are defined and set according to the standard requirements. The penetration of this special insert that is directly measured or calculated by the software, allow the armor producer to verify the protection level or to study new materials and combinations.

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.

Penetration Resistance of Protective Body Armor

The Challenge

Our Solution
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.
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 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 fixtures 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
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.

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.
Manufacturers need a flexible system to evaluate the impact resistance of the raw materials, the finished part, and any accessory that may be added to the finished part after manufacturing. The CEAST 9300 drop tower series is versatile enough to guarantee the test of the raw material (in plate form), as well as testing the protective accessory at different impact energies and speeds. Interchangeable tup inserts of different shapes and sizes, as defined by either a recognized industry or intra-company test standard, can be used in combination with an instrumented tup and data acquisition system to gather impact results. The multi-purpose plate allows the accessory to be placed in the correct test position.

**Applicable Standards**
ISO 20344, ISO 20345, ISO 20346, EN 12492, EN 397, EN 812

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 inoperative.

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 5948 MicroTester is ideal for testing small assemblies or miniature specimens. It combines an ultra-high precision drive system with high-accuracy load measurement to perform tension, compression, and low-cycle fatigue tests with the utmost control and data collection performance. Additionally, a dynamic test system, such as the ElectroPuls™ all-electric test instrument, can be used to perform many different types of quasi-static and fatigue tests on small plastics parts and assemblies. Fatigue-rated wedge action grips or special reverse-stress flexure fixtures can be used to clamp plastic materials while subjecting them to higher frequency dynamic loading.

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.
Applicable Standards
ASTM F1614

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

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.

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
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.
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.

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
Thick 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

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.

Applicable Standards
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.
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.
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.

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.
**Mechanical Testing Systems**

Mechanical testing or universal testing systems are most commonly used for tensile and compression testing. Additional test types include shear, flexure, peel, tear, cyclic, and bend tests. Capacities for these systems range from low load forces of 0.5 kN (112 lbf) up to high-capacity 600 kN (135,000 lbf) test frames. Most systems are configured to run with Bluehill® Software that provides automatic test control, data collection, results analysis, and reporting.

**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 up to heavy duty floor model systems capable of testing strengths up to 600 kN. For applications that require the testing of small assemblies or miniature specimens, the 5948 MicroTester is ideal, offering the ability to test below <2 mN (0.2 g, 0.0004 lbf).
3300 Series
The 3300 Series of mechanical testing systems are ideal for routine, standardized QC tests, providing the simplicity, performance, and affordability needed for quality control and production testing. System capacities range from <0.5 kN up to 250 kN and can be configured for operation with Bluehill® Software or a TouchPanel controller.

Engineered Solutions
Instron® offers Engineered Solutions to solve testing needs with special requirements. Capabilities range from specialized fixtures to fully-automated complex testing systems with robotic specimen handling.
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.

Shore Hardness
Shore® Durometers are designed to determine the indentation hardness of materials ranging from cellular products to rigid plastics. These advanced and high-performance durometers are ideal for hardness testing of elastomers and plastics. The durometers conform to ASTM and ISO standards and include NVLAP® accredited calibration certificate. Instruments range from basic round-style analog models to the more advanced and accurate digital S1 durometer with interchangeable probes, capable of testing in a variety of hardness scales.

Software
While some of our testing systems can be operated in a manual fashion, it is far more common to operate a system that is fully configured with a software package. This makes operating the system easier and more efficient, and offers an extensive range of test control, data collection, results analysis, and reporting tools.
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

**ASTM Standards**
ASTM D638, p15, 16, 19, 20
ASTM D648, p8, 9
ASTM D695, p18
ASTM D732*
ASTM D790, p18, 20
ASTM D882, p17, 20
ASTM D903, p30
ASTM D1004*
ASTM D1238, p7, 9, 11
ASTM D1525, p8
ASTM D1621a*
ASTM D1708*
ASTM D1709, p30, 31
ASTM D1894*
ASTM D1922, p30, 31
ASTM D2240, p19
ASTM D2444, p27
ASTM D2659*
ASTM D3163*
ASTM D3763, p12, 26, 29
ASTM D3835, p7, 11, 12, 13, 20
ASTM D3846*
ASTM D4226, p20
ASTM D5420, p30, 31
ASTM D5458*
ASTM D5748*
ASTM D5930, p12
ASTM D6272a*
ASTM D7192, p30, 31
ASTM F88, p30
ASTM F1306*
ASTM F1614, p27

**ISO Standards**
ISO 75, p8, 9
ISO 178, p18, 20
ISO 306, p8
ISO 527-1, p15, 16, 19, 20
ISO 527-2, p15, 16, 19, 20
ISO 527-3, p17, 19, 20
ISO 604, p18
ISO 844*
ISO 1133, p7, 9, 11
ISO 1421*
ISO 1798*
ISO 1926*
ISO 6259-1*
ISO 6259-3*
ISO 6383-1*
ISO 6603-2, p12, 26, 29
ISO 7619, p19
ISO 7628, p27
ISO 7765-2, p30
ISO 7886-1, p23
ISO 8067*
ISO 8295*
ISO 9854, p27
ISO 11897*
ISO 11443, p7, 11, 12, 13, 20
ISO 16790, p13, 20
ISO 17744, p12
ISO 20344, p25
ISO 20345, p25
ISO 20346, p25

**EN Standards**
EN 397, p25
EN 812, p25
EN 868-5*
EN 1607*
EN 1979*
EN 12492, p25
EN 14509*
EN 50086-2-4*

**DIN Standards**
DIN 53505, p19

**JIS Standards**
JIS K6854-2, p30
JIS K7017*
JIS K7092*
JIS K7125*
JIS K7127, p17, 20
JIS K7161*
JIS K7162, p15, 16, 19, 20
JIS K7171, p18, 20
JIS K7181, p18
JIS K6854-2, p30

**Other Standards**
FDA, p25
NU 0115.00, p21

*To learn more about our solution for this standard, please visit the Testing Solutions section of www.instron.com
<table>
<thead>
<tr>
<th>Analytical Test Type</th>
<th>Standard</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>ISO 1183</td>
<td></td>
</tr>
<tr>
<td>Mechanical Test Type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tensile</td>
<td>ASTM D638, ASTM D882, ISO 527-1,2,3, ISO 1798, ISO 1926, JIS K7127, JIS K7161, JIS K7162</td>
<td>15, 16, 17, 19, 20, 24, 26</td>
</tr>
<tr>
<td>Flexural</td>
<td>ASTM D790, ASTM D6272, JIS K7017, JIS K7171</td>
<td>18, 20</td>
</tr>
<tr>
<td>Compression</td>
<td>ASTM D695, ASTM D1621, ASTM D3846, ISO 844, ISO 604, JIS K7092, JIS K7181</td>
<td>18, 23, 26</td>
</tr>
<tr>
<td>Drop Impact</td>
<td>ASTM D2444, ASTM D3763, ASTM D5628, ISO 6603, ISO 7765, FDA, NJ 0115.00</td>
<td>12, 20, 21, 24-27, 29</td>
</tr>
<tr>
<td>Shore Durometer Hardness</td>
<td>ASTM D2240, ISO 7619, DIN 53505</td>
<td>19</td>
</tr>
<tr>
<td>Drawing Characteristics in the Molten State</td>
<td>ISO 16790</td>
<td>13, 20</td>
</tr>
<tr>
<td>Dynamic/Fatigue</td>
<td>ASTM F1614</td>
<td>21, 26, 27</td>
</tr>
<tr>
<td>Shear</td>
<td>ASTM D3163, ISO 8067</td>
<td></td>
</tr>
<tr>
<td>Elmendorf Tear</td>
<td>ASTM D1922</td>
<td>30</td>
</tr>
<tr>
<td>Compression Set</td>
<td>ASTM D395</td>
<td></td>
</tr>
<tr>
<td>Falling Dart Impact</td>
<td>ASTM D1709, ISO 7765</td>
<td></td>
</tr>
<tr>
<td>PVT tests</td>
<td>ISO 17744</td>
<td>12</td>
</tr>
<tr>
<td>Environmental Stress Cracking</td>
<td>ASTM D1693</td>
<td></td>
</tr>
<tr>
<td>Thermal Test Type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coefficient of Thermal Expansion</td>
<td>ASTM D696, ASTM E831, ASTM E1545, ISO 11359</td>
<td></td>
</tr>
<tr>
<td>Heat Deflection Temperature HDT</td>
<td>ASTM D648, ISO 75</td>
<td>8, 9</td>
</tr>
<tr>
<td>Vicat Softening Point</td>
<td>ASTM D1525, ISO 306</td>
<td>8</td>
</tr>
<tr>
<td>Thermal Conductivity of Melt</td>
<td>ASTM D5930</td>
<td>12</td>
</tr>
<tr>
<td>Britteness Temperature Test</td>
<td>ASTM D746, ASTM D2137, ISO 974</td>
<td></td>
</tr>
<tr>
<td>Carbon Black Content</td>
<td>ASTM D1603</td>
<td></td>
</tr>
<tr>
<td>Rheological Test Type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Melt Flow Rate (MFR)</td>
<td>ASTM D1238, ASTM D3364, ISO 1133</td>
<td>7, 9, 11</td>
</tr>
<tr>
<td>Melt Flow Index (MFI)</td>
<td>ASTM D1238, ASTM D3364, ISO 1133</td>
<td>7, 9, 11</td>
</tr>
<tr>
<td>Melt Volume Flow Rate (MVR)</td>
<td>ASTM D1238, ASTM D3364, ISO 1133</td>
<td>7, 9, 11</td>
</tr>
<tr>
<td>Capillary Rheometry</td>
<td>ASTM D3835, ASTM D11443</td>
<td>7, 11, 12, 13, 20</td>
</tr>
<tr>
<td>Specimen Prep</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Miling</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Bar Notching</td>
<td>ISO 2818</td>
<td>17</td>
</tr>
</tbody>
</table>

*To learn more about our solution for this standard, please visit the Testing Solutions section of www.instron.com*
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.
Global Support that is Local to You

Instron® has a global infrastructure that is local to you and remains committed to being the leader in mechanical testing instrumentation.

For additional country contacts visit www.instron.com/locations