LABORATORY

TESTING TECHNIQUES

FOR INDUSTRY

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Laboratory Testing Techniques for Industry

Introduction

Laboratory testing is carried out in almost every industry sector. The range of techniques available is huge and to make things harder, there are often many different methods for the same type of test.

This eBook contains a set of comparison charts to help anyone involved with testing. There are charts for a wide range of types of testing and each chart explains the applications for each type of test and its advantages.

This first edition of '**Laboratory Testing Techniques for Industry**' contains the following charts:

- **Fire Testing**
- **Hardness Testing**
- **Mechanical Testing**
- **Solder Analysis**
- **Thermal Characterisation**

Everyone who downloads a copy of this edition will receive a copy of each future edition as soon as it is published. Future editions will include a wider range of charts.

The charts have been compiled by the team at **ITRI Innovation**. Accredited by UKAS to ISO 17025 (No.4119) ITRI Innovation is a key global provider of contract testing and consultancy services to a broad customer base.

Headquartered in the South East of England our laboratory is run by a team of scientific and product development professionals involved in chemical, physical and microstructure analysis, materials testing, process engineering, product design and failure investigation.

For more information visit our website at **www.itri-innovation.com** or call us on **+44 1727 875544**.

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Fire Testing Comparison Chart

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Test	Sample Size	Advantages	Standards	Applications	Technique
Cone Calorimetry 	It is recommended that three test samples at a size of 100mm x 100mm x 2-50mm thick are to be tested	This test can simulate a range of fire intensities and provides data results that correlate well with full-scale fire tests	ISO 5660; BS476 (Part 15); ASTM E1354 and ASTM E1474	This test is for measuring the rate of fire growth and the maximum heat intensity of a sample material. It can also be used to determine: time to ignition; peak rate of heat release; fire performance index; smoke parameter; MAHRE and FIGRA.	The testing technique can be applied to samples horizontally using a technique referred to as oxygen depletion calorimetry to measure the evolved heat. The sample material is ignited under the cone, where it burns and measurements are taken
Limiting Oxygen Index (LOI) 	For an injection-moulded sample: 120mm long x 7mm wide x 3mm thick	The sample specimen can be loaded quickly into the machine, which brings time and cost down. The digital display of oxygen percentage and temperature cuts out the need for calculation time	ISO 4589-2; BS2782 (Part 1 Method 14) and ASTM D2863	This test is used for determining the flammability of polymeric materials. It can also be used for comparative testing to measure relative flammability, as measured by % O_2 required for a sample to burn.	The sample is put vertically into a glass chimney, where it is ignited and the oxygen concentration is increased and decreased, until a critical oxygen level is determined when the flame is supported for three minutes.
UL-94 Flame Test 	The preferred size for a sample is 127mm x 12.7mm x 0.8-12.7mm thick. Two sets of five samples to be submitted.	This is a widely used test, which is also commonly used as a certification test in the building industry.	The flame test itself is classed as a standard to ensure polymer products are within the flammability guidelines	This test is for classifying plastics according to how they burn. This technique is also used for a pass/fail grading for vertical or horizontal tests.	There are horizontal and vertical flame tests, which classify polymers in one of these categories: UL-94-HB; UL-94-V2; UL-94-V1; UL-94-V0; UL-94-5B and UL-94-5VA. The technique is to apply the flame for 10 or 5 seconds and then remove the flame for 10 or 5 seconds and then repeat the process.
NBS Smoke Density Test 	The sample size required for this test is 76mm x 76mm x 2-10mm thick	The NBS chamber is versatile, as it has controlled ventilation, ongoing weight monitoring, toxicity measuring capabilities and one-dimensional heat flux.	BS6401; ISO 5659-2; ASTM E662 and NFPA 258	This test is used to measure the amount of smoke generated by a burning material. Smoke density testing can also be used to determine different types of smoke density, these tests are: Measuring Specific Smoke Density (Ds) and Maximum Specific Smoke Density (Dmc)	The sample material is placed horizontally or vertically in a smoke box or chamber, where it is burned in the flaming mode or non-flaming mode (smouldering). The smoke propensity is measured by the obscuration of a light beam travelling through the smoke.

We hope this comparison chart is useful in helping you to determine which fire testing technique might be appropriate for your needs.

For more information on fire testing options, call **Alastair Monk** at ITRI Innovation on **01727 871301** or email him at **alastair.monk@itri.co.uk**
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Hardness Testing Comparison Chart

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Test	Sample Size	Advantages	Standards	Applications	Technique
Rockwell Hardness Testing 	Small plate sample approximately 20mm x 20mm	This is a rapid test that usually takes no longer than ten seconds, provides a direct readout and is non-destructive so samples can usually be used again.	ASTM E18	Rockwell hardness test determines the hardness and strength of a material. It has other applications, which include: quality control for metal heat treatment, failure analysis, grade verification for plastics, weld evaluations and incoming material inspection. We can also provide temper testing for tin plate, which involves either applying a tensile testing technique or a hardness testing technique to the tinplate sample.	The sample is subjected to a minor load being applied followed by the application of a major load that causes an indentation. The indentations from both minor and major loads are compared to determine the hardness of the sample material.
Microhardness 	Typical sample approximately 50mm x 50mm	Micro hardness testers enable surface sensitive hardness tests to be performed rapidly, accurately and reliably in both industrial research (metals, sintered materials, ceramic products, integrated circuits, coatings, grain microstructure analyses) and in quality control environments (heat treated surfaces, cutting tools, wires, small-scale precision engineered components).	The standards to this testing technique are dependent on application. Information on standards can be supplied once the application has been confirmed.	They are particularly suitable for: examining the different phases in heterogeneous alloys (e.g. distinguishing between microstructure hardness, polycrystalline hardness and monocrystalline hardness): demonstrating diffusion processes :verifying increasing hardness as the alloy concentration in a mixed crystal is raised: mapping hardness zones from the surface into the body of the sample: hardness measurements on thin films: hardness measurements on components with a very small test surface area: hardness testing of parts whose surface must not be damaged to any large extent.	The indenter used in this technique is a square-based diamond pyramid with included face angles of 136°. The tester is controlled via the serial interface of a computer running special control and image processing software. This technique has a high reproducibility level and operator error is very unlikely.
Vickers Hardness Testing 	Typical sample approximately 50mm x 50mm	This technique is capable of providing extremely accurate readings, along with only having to use one type of indenter for all types of metals and surface treatments	ASTM E384	Vickers hardness test determines the hardness of a material and its ability to withstand deformation from a typical source. The test is also used for testing very thin materials, measuring the surface of a part, measuring individual microstructures and measuring the depth of case hardening.	This test applies various loads to the material using a Diamond Head indenter. The ratio of force applied, to surface area indentation is measured, which determines the hardness of the sample.

We hope this comparison chart is useful in helping you to determine which hardness testing technique might be appropriate for your needs.

Testing can be relatively inexpensive, especially if it is carried out under contract where testing of components is carried out routinely.

For more information on hardness testing options, call **Dr Wayne Lam** at ITRI Innovation on **01727 871328** or email him at **wayne.lam@itri.co.uk**. Alternatively call **01727 875544** or visit the ITRI Innovation website at **www.itri-innovation.com**.

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Mechanical Testing Comparison Chart

Test	Sample Size	Advantages	Standards	Applications	Technique
Charpy Impact Testing 	Typical size – 130 x 13 x 3.2mm. The size can vary dependant on the standard being tested to. We can generate an appropriate sample from the supplied material. If you are unsure, we can advise whether a material is suitable for testing.	It is a simple technique, therefore requires less time to perform the testing. Specimens used tend to be small, so there is no need to use too much material on sample preparation. This testing technique can be applied using a range of temperatures. Both Izod and Charpy testss are both interchangeable depending on the end use requirements.	ASTM D6110, ISO 179	Charpy testing is mainly used in the research of new materials or quality control work. It is also used to determine whether or not a material meets requirements and if it is brittle or ductile.	The sample is held in a three-point bending configuration whilst the pendulum is dropped to cause an impact. The absorbed energy is a measure of the material's toughness. The more energy absorbed, the more ductile the material.
Tensile Testing 	There is a large variance in samples that can be accepted. We can generate an appropriate sample from the supplied material. If you are unsure, we can advise whether a material is suitable for testing.	This test has the advantage of providing integrity and safety data of components, materials and products, which helps manufacturers provide evidence that their finished products are safe and of high quality.	ASTM B913, ASTM D76, ASTM D1876, ASTM D3822, ASTM D412, ASTM D638, ASTM D828, ASTM E8, ISO 37, ISO 527.	Tensile testing is most commonly used to determine characteristics such as tensile, compression, bend, peel, shear, tear and cyclic. It can also be used to obtain material property data, simulation of component mechanical performance in service and to ensure compliance with standards.	This technique involves loading the sample into the equipment and gradually extending it until it causes the sample to fracture. The elongation of the gauge section is recorded and compared against the applied force, which determines how the material reacts under tension and force.
Izod Impact Testing 	Typical size – 80 x 10 x 4mm. The size can vary dependant on the standard being tested to. If required, we can generate an appropriate sample from supplied material. If you are unsure, we can advise whether a material is suitable for testing.	This technique is fairly simple and does not require a lengthy time to perform the testing. Samples used are usually small, which means only a small amount of material for sample preparation is needed. This technique can be applied using a variation of temperatures. Both Izod and Charpy tests are both interchangeable depending on the end use requirements.	ASTM D256, ISO 180	Izod testing is typically used to determine the impact resistance of materials and if the material is brittle or ductile. This test can also be used to test materials at low temperatures, to simulate conditions seen within industry application.	The sample is held in a cantilevered beam configuration, and then a pendulum is dropped to cause an impact. The sample will either break or the weight will rest upon it, which will determine the impact energy and sensitivity.

We hope this comparison chart is useful in helping you to determine which mechanical testing technique might be appropriate for your needs.

Testing can be relatively inexpensive, especially if it is carried out under contract where testing of components is carried out routinely.

For more information on mechanical testing options, call Mark Dowling at ITRI Innovation on **01727 871316** or email him at **mark.dowling@itri.co.uk**. Alternatively call **01727 875544** or visit the ITRI Innovation website at **www.itri-innovation.com**.

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Solder Analysis Comparison Chart

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Test	Sample Size	Advantages	Standards	Applications	Technique
Joint Strength Analysis 	There is a variance in samples that can be tested for joint strength. We can advise whether a material, sample or PCB component is suitable for testing.	This technique can be used as a comparative tool for the analysis of solder joints. Joint strength analysis is able to examine failure modes, the susceptibility to damage of the board by vibrations and produce different profiles in the solder process.	ASTM D1002	This technique measures the strength of solder joints and compares them against similar joints prepared by a different process.	There are two ways of carrying out this test, the first is the shear strength push method in which a flat test face is pushed against the side of a chip component and the load to failure is recorded. The other is the tweezers pull test where the lead terminations are held by the tweezers and pulled until removed from the board with the load recorded.
Microsectioning 	Small plate sample approximately 20mm x 20mm	The advantages of using this test is the maintenance of a planar surface on samples having adjoining areas of different physical characteristics; boundary details are not affected due to using a rounding-off technique and precise positioning of the sectioned sample.	ASTM E 3	Microsectioning is used to determine a variety of attributes although ascertaining the nature of the interface between solder and PCB is one of the most common uses. Other applications include revealing coating layer uniformity and thickness in plating finishes; assessing wave solder fill; checking de-lamination of PCB substrates and failure analysis on components and materials.	A section from a PCB is carefully removed and then placed into a potting medium and left to cure. Once the sample has been cured and is solidified, the face is gradually receded back using abrasive techniques. The sample is then polished and ready for optical or electron microscopy.
Solderability 	Electronic components or solders can both be examined	The technique can be used to quickly analyse either the solderability of a component or a package or it can be used to examine solder performance across different components either on the line or in a reseach environment	IPC/ECA J-STD-001, J-STD-002, J-STD-003; MIL-STD-202, Method 208; MIL-STD 883, Method 2003.10; IPC-TM-650	Solderability testing provides a means of determining the solderability of device package terminations that are intended to be joined to another surface using SnPb or Pb-free solder. The procedure, considered to be destructive, will test whether the packaging materials and processes used during the manufacturing operations produce a component that can be successfully soldered in the next level assembly.	There are two methods of solderability testing. Method 1 is known as "dip and look" which is for leaded and leadless terminations. The method includes pre-conditioning if applicable, the application of flux, and the immersion of the terminations into molten solder. Method 2 is a Surface Mount Process Simulation test.

We hope this comparison chart is useful in helping you to determine which solder analysis technique might be appropriate for your needs.

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Thermal Characterisation Chart

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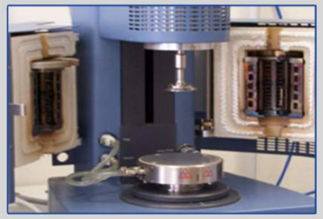
Test	Sample Size	Advantages	Standards	Applications	Technique
Dilatometry Testing 	Typical size – 20mm length x 10mm diameter. There is a large variance in samples that can be accepted. We can generate an appropriate sample from the supplied material. If you are unsure, we can advise whether a material is suitable for testing.	This testing technique can determine accurate values for changes in the size of the material subject to temperature variations. Dilatometers have been used in the fabrication of metallic alloys, compressed and sintered refractory compounds, glasses, ceramic products, composite materials, and plastics.	ASTM D6635; ASTM E228	Dilatometry testing is used to carry out thermal expansion analysis or thermal shrinkage analysis. This is particularly useful for samples that will be subject to temperature in its final application.	This technique uses interchangeable probes at a negligible load that measures the effects on solids, powders, pastes and liquids when subjected to a controlled temperature and/or time program.
Rheometry Testing 	There is a large variance in samples that can be accepted. We can generate an appropriate sample from the supplied material. If you are unsure, we can advise whether a material is suitable for testing.	This test has easy handling so it is a quick procedure, which can determine the true viscosity and has a temperature ramp and high shear rate.	The standards to this testing technique are dependent on application. Information on standards can be supplied once the application has been confirmed.	Rheometry is used to determine the structural and compositional changes that affect flow and deformation in a material. It can also be used to determine direct stress and strain control, shear viscosity, temperature dependence, elongational viscosity, stability, elasticity, wall slip, melt fracture, materials selection, aspect ratio, stress relaxation, flow visualisation, yield stress, thixotropy and creep.	The sample is put into the gap in the measuring system, which imposes shear flow when rotated, and replicates the flow and deformation found in extrusion and injection moulding. Rotating, oscillating or applying a step function determines the characteristics.
STA Simulateous Thermal Analysis (DSC and TG) 	Typical size is between 10 and 50milligrams. Although TGA it is capable of doing upto 5grams	Small scale analysis of various materials to determine thermal properties, weight loss due to temperature and fillers loadings.	The standards to this testing technique are dependent on application. Information on standards can be supplied once the application has been confirmed.	The technique is used to analysis the breakdown of material at temperatures up to 15000C. This has particular use in the minerals, ceramics, glasses and refractory industries.	The sample is put into a crucible with or without lid and heated to required temperature. The test conditions are perfectly identical for the TG and DSC signals (same atmosphere, flow rate, vapor pressure on the sample, heating rate, thermal contact to the sample crucible and sensor, radiation effect, etc.).

We hope this comparison chart is useful in helping you to determine which thermal characterisation technique might be appropriate for your needs.

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