Executive Summary

**Micro-Tensile Test System**

**Description**

The Micro-Tensile Test System (MTTS) measures the physical properties of very small objects, such as LIGA-engineered materials. The system measures samples between 0.002 inch and 0.030 inch with loads up to 250 pounds. This is much smaller than most commercial testers are able to measure. The MTTS consists of a computer for test control, a test frame to provide rigid sample support, and a load cell to read the applied load. In addition, the system contains dual laser extensometers to measure strain on both sides of the sample. A linear actuator and keypad provide controlled displacement as well as operator control. PC-based software in the system collects and analyzes a variety of engineering properties such as Modulus of Elasticity, yield strength, ultimate strength, failure strength, and elongation at failure.

**Background**

The trend in physical technology is toward miniature- and nano-level structures. This presents unique challenges in fabrication, manufacturing, and particularly, in testing for quality assurance. As a national leader in applied LIGA processes for manufacturing, the Kansas City Plant has designed the MTTS with the capability to examine small components with more accuracy and less difficulty. This enhanced testing system has special, user-friendly features that include a stand-alone test platform, serrated specimen grips, and data acquisition software.
Advantages

The Kansas City Plant uses the MTTS for weld verification and to test the physical and engineering properties of LIGA-engineered and similar materials. Other users of the MTTS will find a number of advantages. The serrated specimen grips, key-pad user control, and precise sample alignment all decrease the tedium of the testing process while increasing system accuracy. The MTTS measures much smaller samples than previous test equipment. The alignment and calibration of the improved MTTS meet the requirements of ASTM-E4; the data acquisition software allows the various properties generated from tests to be analyzed and viewed with a personal computer.

Applications

The MTTS has a broad range of applications for research, university, and engineering test laboratories. The flexibility of the system enables testing of virtually any sample meeting the size/load requirements. The MTTS is capable of both static and dynamic testing, and it is designed for use in tensile, compression, flex, shear, and cyclic modes on a variety of materials, specimens, and components. The MTTS promises benefits to the following applications.

• Biomedical—The MTTS can test biomaterials as well as characterize the biomechanical properties of medical and dental devices. These include implantable apparatuses, prostheses, and other materials where low force determination is required.

• Materials manufacturing—The MTTS can perform physical tests on virtually any type of material, including metallics, paper, cardboard, elastomers, packaging, adhesives, textiles, composites, plastics, and ceramics.

• Miniature and micro-components manufacturing—Any application that involves miniature specimens, such as microelectronics manufacturing, will find the MTTS to be a versatile solution for materials testing.
The Micro-Tensile Test System (MTTS), designed to test materials that range from 0.002 inch to 0.030 inch with loads up to 250 pounds, provides precision for testing very small samples. This new system examines the physical and engineering properties of these samples: Modulus of Elasticity, yield strength, ultimate strength, failure strength, and elongation at failure.

For small samples, the MTTS is an important improvement over existing commercial systems. Standard tensile testing techniques used with larger samples do not work for micro-scale samples. With very small parts, the attachment-type extensometers used to measure sample displacements in larger samples are too large and inadequate for the sample size. Instead, the MTTS relies on serrated grips and linear bearings to hold the sample in place, while dual laser extensometers measure gage section displacement.

The steel load frame of the MTTS makes it rigid, allowing axial loads of up to 250 pounds with minimal error in test results. In addition, the sample is aligned precisely to ensure even distribution of force during testing. The load/strain measurements of the MTTS have less than a 1% error rate due to these distinct features. Other key features are:

- Interchangeable load cells can be changed to record the applied force on the sample.
- Keypad user control contributes to the ease of conducting tests with the MTTS.

The MTTS is a stand-alone system and meets the calibration and alignment requirements of the ASTM-E4. It is used by the Kansas City Plant to determine properties of LIGA-engineered materials and to test weld verification, but its flexibility allows it to perform tensile testing on a variety of micro-sized materials. The system is able to perform both static and dynamic testing. It can execute tensile, compression, flex, shear, and cyclic mode tests on a variety of materials, specimens, and components.

Because the MTTS was designed for use in a testing laboratory to provide accurate and reliable tensile tests, it has immediate application for the R&D and academic communities. On the commercial side, the MTTS has strong potential across manufacturing, but especially in the areas of:

- Medical and biomaterials manufacturing;
- Medical and dental devices;
- Prostheses, components, and materials that require low force determination;
- Microelectronics materials;
- Materials manufacturing of virtually any type of material;
- Any application involving miniature specimens.

Medical and biomaterials manufacturing;
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The Kansas City Plant is the Nation’s primary manufacturer of mechanical, electronic, and engineered material components for the National Nuclear Security Administration. For more than 50 years, our associates have led the way in science-based manufacturing technologies. Arming devices, microcircuits, plastics, radars, and polymers are among the 42 product families assembled and manufactured within the highly secure Kansas City Plant. We also support more than 90 advanced technologies that improve product efficiency. In addition, our associates work continuously with national laboratories, universities, and commercial enterprises to develop new technologies. By applying cutting-edge science to real-world manufacturing problems, we turn science into reality.

with unsurpassed technical expertise.

We are committed to developing new products, to improving production processes, and to advancing the technical capabilities of our associates. This enables the Kansas City Plant to provide customer-focused solutions. Our technical expertise gives us the ability to adapt to changing requirements, the agility to respond quickly, and the confidence to meet new challenges. Never satisfied with the status quo, we strive to exceed customer expectations. Smarter, faster, and stronger than ever, the Kansas City Plant sets the standard in technological innovation.

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