ROMULUS

UNIVERSAL MECHANICAL STRENGTH TESTER

- Instrumented Indentor
- Blade Adhesion
- Stud Pull Adherence
- Diamond Scratch
- Tensile Stress/Strain
- Flexure Stress/Strain
- Peel Test
- Die Bond Shear
- Die Bond Pull
- Torque Test
- MCM Interconnect
- And Many More...

Quad Group Inc.

ROMULUS

UNIVERSAL MECHANICAL STRENGTH TESTER

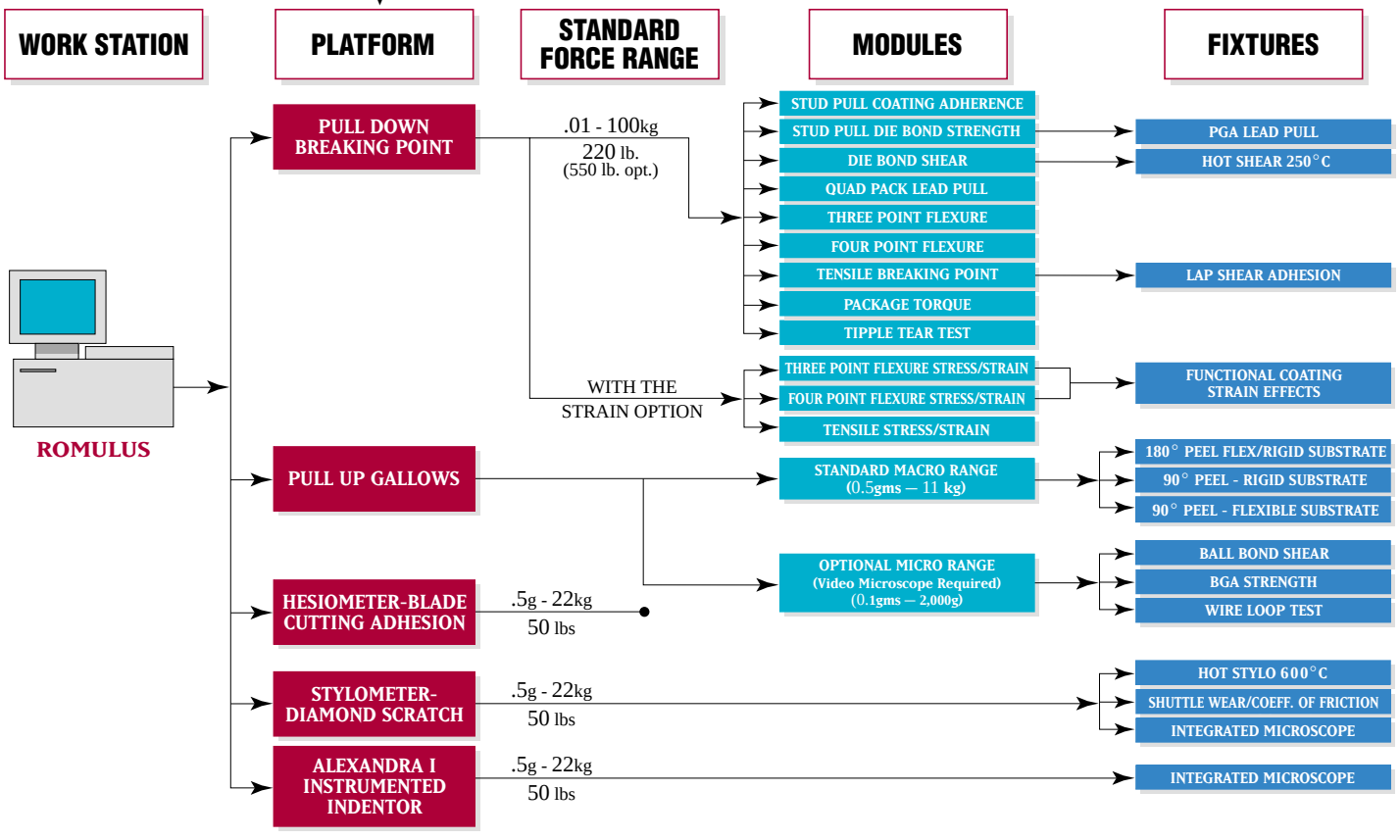
THE ROMULUS UNIVERSAL TESTER IS A COMPUTER OPERATED TEST INSTRUMENT FOR EVALUATING: ALL FORMS OF ADHESION, MICROELECTRONIC WAFER FAB, INTERCONNECT TECHNOLOGY, MATERIALS CHARACTERIZATION, AND MANY FORMS OF COATING AND MANUFACTURING Q.C. TESTS.

Since there is no universal mechanical strength test method for a broad range of applications, Quad Group has created a single instrument on which various forms of test platforms can be installed. You only need to purchase the unit currently required. As needs arise, the capabilities can be quickly enhanced with a myriad of low cost standard test options. The design of the Romulus system allows for customized modules and fixtures to fit your special needs. Thus, an entirely new instrument can be configured by Quad Group in a short amount of time and at a fraction of the usual custom cost.

The basic instrument is portable, compact (approximately the size of a personal computer), contains no messy hydraulic systems, and is simple to operate. Some tests, such as stud pull, require rate of loading control. Other tests, such as peel, require rate of travel control. The internal computer selects the appropriate method. While the standard range is .05 to 100 kg. Force (.1 to 220 lbs.), the instrument can be configured to apply test forces of one gram to 3/4 ton. All calibration is traceable to NIST (U.S. National Bureau of Standards).

Five interchangeable platforms allow the user to configure over 50 different tests at a fraction of the cost of individual machines for each test.

Once any instrument is purchased, other platforms, modules and fixtures may be added individually as your testing needs change. Please contact the Quad Group for any special requirements or tests that are not included in the chart below.



BREAKING POINT PLATFORM (100 kg Std., 220 kg optional)

EXECUTING ANY TEST

THE METHOD USED TO EXECUTE ANY TEST IS IDENTICAL. ***COMPUTER LITERACY IS NOT REQUIRED!***

1. Select and install the test module desired.
2. Access the software appropriate for that test.
3. Install the sample and respond to the software prompts.

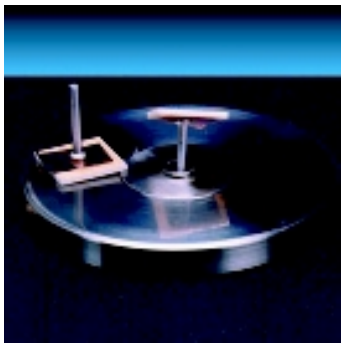
The test is executed automatically, the data is recorded on a real time basis. Primary findings and numeric constants are calculated automatically. A broad range of statistical analysis tools are included in the software.

STUD PULL TESTS

All stud pull tests are performed by bonding the pre-epoxy coated face of a nail shaped stud to the sample surface, and then applying an exact perpendicular controlled rate of force until sample failure. Cure temperature for Quad Group epoxy is 150° C (300° F). Our 70 MPa (10,000 psi) epoxy bonds to virtually any solid, is low stressing if a small stud is used, and goes from enamel-like to water consistency just prior to polymerizing. This optimizes exact perpendicular stud mounts. A weaker, more elastic version is used for large area bonding to die bond tests. Low cure temperature epoxy is available.

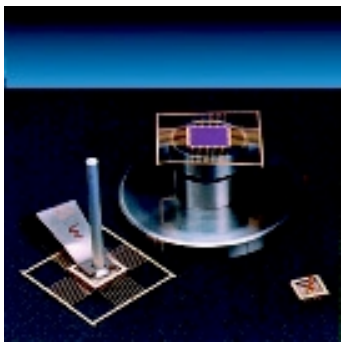
Stud Pull Adherence

This test is applicable to the evaluation of any coating. Simply select the units of measure desired, insert a prepared sample in the apparatus for automatic detachment. The same fixture is used in axial lead pull and bonding media strength tests.



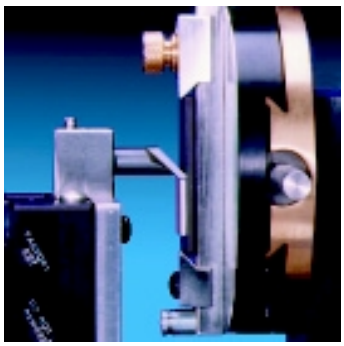
Tensile Die Bond Test

To test the bond strength of die or surface mounted components, (Mil. Std. 883) a stud is attached to the face of the component. It is similar to the above test except that much larger studs are used. A swivel is present to accommodate any non-parallelism between the component and its substrate.



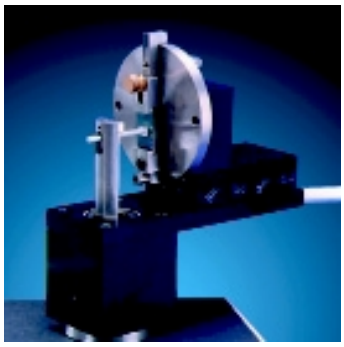
SHEAR TEST

A quick die-bond test which requires no sample prep and is executed in seconds. As per Mil Std. 883, the sample is brought in contact with the shear tool by X,Y,Z and rotational adjustments. A shear wedge is forced against the component edge until failure. Excellent for SMD components.



TEAR TEST

The Tipple Tear unit tests the tear strength of coatings and composite edges. Rectangular faced studs are bonded to the coating surface or substrate edge. A load is applied 90° to the stud axis, tearing the coating or composite edge. Also tests PCB edge fretting.



FLEXURE BREAKING POINT *

Measures flexural Modulus of Rupture of Ceramics or stress induced changes in *functional coatings*, such as magnetostriction, by maximum outer fiber stress analysis. Quick incontrovertible Q.C. analysis for rejection of improper chemistry or firing schedule of ceramics. Advanced stress/strain facilities are available.

TENSILE BREAKING POINT *

Tensile test samples are gripped between the Romulus gripper and an identical downward looking grip of the module. The sample is pulled at a constant rate of travel. Fully automated ASTM stress/strain analysis for scientific level materials analysis is optional.

* Many breaking point tests can not be included here. Call Quad Group with your special needs.

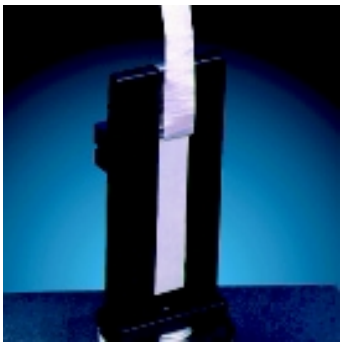
PULL-UP PLATFORM (.1g — 7kg)

PEEL TESTS

All pull up/peel tests are executed using a gallows structure mounted on a platform deck. It contains a take-up wheel with a precisely setable peel rate. A sample holder appropriate to each test is mounted in the force transducer, located below the deck. The peel force is continually measured. Tape assisted peel of non-self-supporting coatings can be executed by the tests described below.

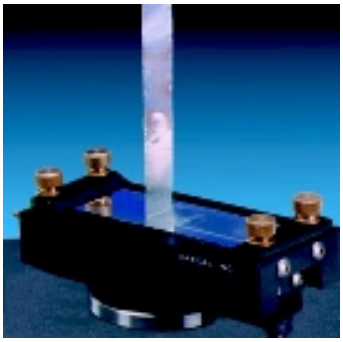
The 180° Peel Test

Both flexible and rigid substrate tests are executed using the unit shown to the right. Rigid substrates are clamped onto the unit face; flexible substrate material is clamped and tensioned on the rear of the plate. The unit can execute peel-back tests for coatings, tapes, labels, and laminates.



The 90° Rigid Substrate Peel Test

A pulley-driven stage moves laterally at the same rate as the vertical pull rate. This maintains the 90° angle established at the test start. Aggressive tape can be used to test thin or fragile coatings. Tests include hybrid bond pad peel and micro-range pull up tests. For "J", "L" and gull wing bond see right of page.



The 90° Flexible Substrate Peel Test

By mounting the sample on the periphery of a free running German Wheel, the coating is peeled from the substrate. The 90° angle is maintained by the free rotation of the wheel. Additional tests include evaluation of the adhesion uniformity of tapes and labels.

INTERCHANGABILITY

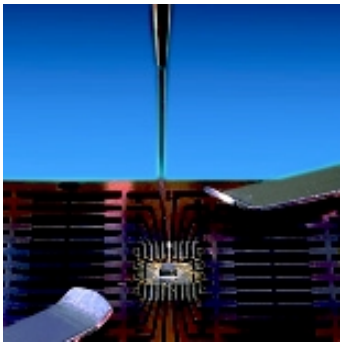
Any and all Romulus platforms can be interchanged in seconds. Pull-up handles facilitate easy removal of any platform. Simply pull deck plate, then replace with a new platform in seconds. All modules and accessories from earlier Quad Instruments can be used directly in appropriate Romulus platforms.

MICRO RANGE PULL-UP TESTS

ROMULUS can be outfitted with a low range force transducer for executing a large number of specialized micro-range tests covering the load range of 1g to 2000g. Each uses the pull-up facility used in all peel tests, a few of the many possibilities are described below. Quad video microscope may be necessary.

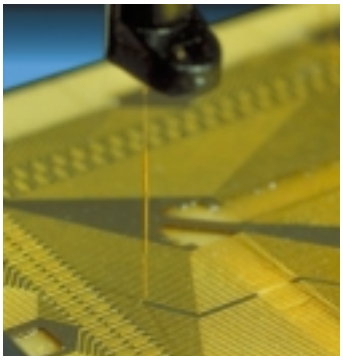
Wire Loop Test

Samples are held on an X-Y floating stage. Any wire can be engaged by a micro-hook which is stabilized by a linear bearing and suspended from the take-up wheel. Hook engagement of micro wires requires the video microscope option. Also adaptable to ball pull and stitch pull.



TAB Bond Peel Test

The Low Force Pull-Up unit can be outfitted to measure TAB conductor traces by hook methods or direct peel. A gram level force is applied to peel the entire TAB or beam lead length from the chip, through the fan out and to the bond pad. By continuing the pull-up, the tensile strength of the TAB is measured.

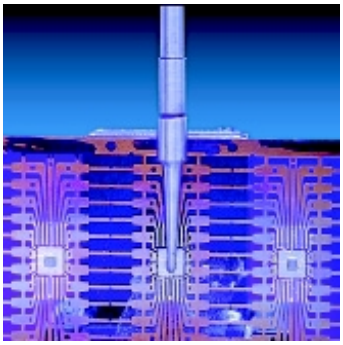


SMT Lead Peel Test

The SMT device is cut at the package line and each individual lead is clamped and peeled to evaluate the solder bond strength for "J" and "L" bonds. Gull wing bonds can be peeled to show region of minimum strength.

Ball Bond Shear Test

A structure, identical to the wire bond structure, is used, except that a micro-shear wedge replaces the micro hook. Force is applied against a ball bond or micro-component edge, with failure load measured on the micro-range transducer. Also perfect for rows in Ball Grid Arrays.



BLADE CUTTING ADHESION TEST

THE **HESIOMETER** IS A SOFTWARE DRIVEN BLADE CUTTING ADHESION TESTER INTENDED FOR USE IN TESTING THE BOND STRENGTH OF EPOXIES, BONDING AGENTS, PAINTS AND INKS, LAMINATES AND OTHER THICK COATINGS.

For all but viscoelastic coatings there is an optimum blade force and angle which cause a sharp blade to project an interfacial splitting plane down a coating interface. The interface splitting condition is sensed by the acoustic energy created, and by cutting force changes.

Practical adhesion tests do not require sample preparation. Scientific level *intrinsic adhesion energy* tests require special techniques and sample preparation.

TOOLING

The Hesiometer platform consists of a cutting head assembly above the deck (see photograph), a pull-down force system and a transducer below the deck.

The cutting head contains a vertically mounted sample holder, which moves at a constant rate of travel, and an assembly containing a hyper-sharp blade with precision goniometer for resetting blade angle to an exact location.

Optimum blade angle and blade force must be empirically derived for different coating types prior to testing. The test is unique in that it can evaluate multi-layer structures where weak layers underlie highly adherent layers.

INSTRUMENTED INDENTATION

THE **ALEXANDRA I** IS DESIGNED TO MEASURE THE HARDNESS, YOUNG'S MODULUS, YIELD STRENGTH, STRAIN HARDENING AND A NUMBER OF OTHER PARAMETERS FROM THE EVALUATION OF CONTINUOUS LOAD-DISPLACEMENT DATA. THIS IS ACCOMPLISHED BY COMPUTER CONTROLLED INDENTATION OF A RIGID INDENTOR INTO THE SAMPLE'S SURFACE.

The **Alexandra I** is intended to characterize all materials of thickness above 5 micrometers and is especially valuable in determining the properties at various depths, such as with Ion-Beam Modified Materials, IBMM.

MAJOR APPLICATION

The major application for the **Alexandra I** Instrumented Indentor is a simple and quick method for determining the mechanical properties associated with the TOUGHNESS of solid materials, or the capacity to absorb energy. The degradation of toughness (durability) as a function of exposure to various environments are readily appraised. The major advantage over traditional tensile and hardness tests is the amount of time involved in sample preparation and testing. The **Alexandra I** requires only a flat sample specimen with a smooth surface, so preparation is minimized. Also, a single analysis can be accomplished in approximately 100 seconds. Statistically significant numbers of tests can be done in a few hours.

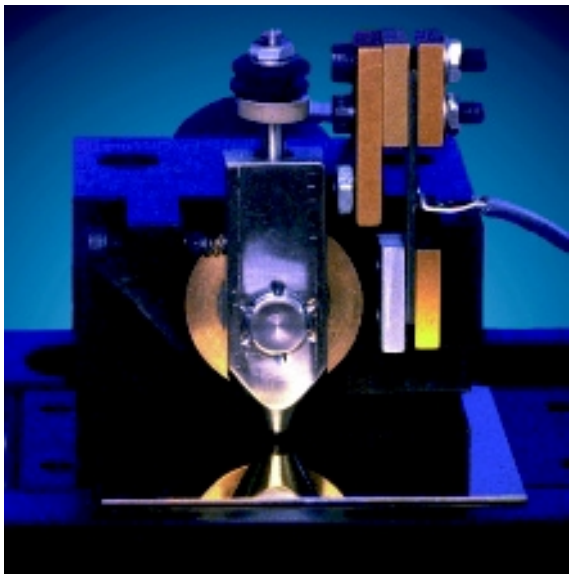
ROMULUS

DIAMOND SCRATCH COATING ADHERENCE TEST

THE **STYLOMETER** IS A SOFTWARE DRIVEN DIAMOND SCRATCH COATING ADHERENCE TESTER. IT IS INTENDED FOR THE TESTING OF ALL KINDS OF THIN FILMS AND IS ESPECIALLY VALUABLE IN THE TESTING OF TRIBOLOGICAL OR WEAR COATINGS WHOSE ADHERENCE NORMALLY EXCEED THE MEASUREMENT RANGE OF ALL OTHER KNOWN ADHERENCE TEST INSTRUMENTS.

A spherical diamond is pressed against a coating surface at a constant rate of loading as the sample moves at a constant rate of travel. Force is increased until the coating catastrophically fails. The failure force is a measure of relative adherence for samples of similar character and thickness.

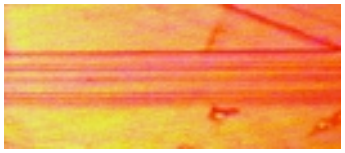
It is believed that techniques can be developed to measure coating tensile strength, elastic limit, scratch resistance, friction coefficient and other physical properties.



TOOLING

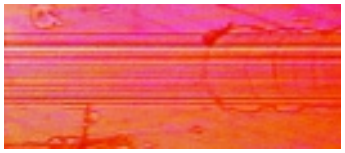
The scratch platform, in the photograph, contains the diamond stylus, constant rate of travel sample stage, and a force measurement transducer which is mounted below the deck. An acoustic transducer, mounted on the stylus, is used to identify the point of initiation of sample micro-cracking and senses the coating or substrate failure. Acoustic energy, applied diamond force and coating removal force are plotted as a function of travel distance, as well as effective friction.

INCOHERENT SCRATCH



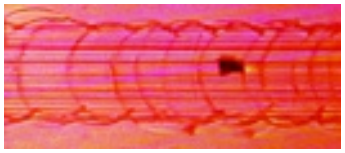
At very low diamond force the diamond creates an incoherent scratch consisting of striations in the travel direction. As the force increases, this track may widen. No coherent information is derived from this portion of the test.

MICRO-CRACKING



When the transverse, or diamond drag, stress reaches the tensile strength of a non-brittle coating, a micro-crack is created normal to the travel direction. Bursts of acoustic energy are released as the coating rebounds.

COATING FAILURE



If the coating is poorly adherent, the micro-crack fails catastrophically and large areas of coating are pulled away. For better adherent coatings (as above), there will be a substantial number of micro-cracks generated before coating failure.

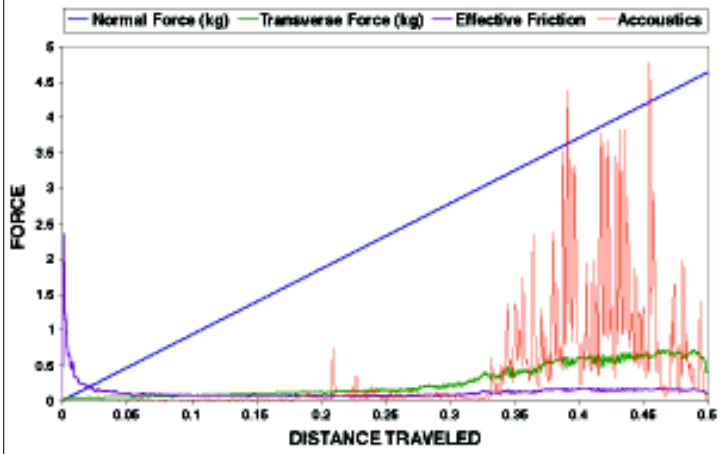
SUBSTRATE FAILURE

If the compressive strength of the substrate is exceeded, portions of the substrate surface are crushed. This condition results in high energy noise bursts and normally increases the transverse force and effective friction.

INTERPRETATION

From the force measurements the "effective friction" is calculated and plotted. During the initial portion of the test the diamond slides across the coating; thus the acoustic output is low; the effective friction constant. When micro-cracking of the coating starts, the acoustic output increases. Abrupt increases in applied force, drag force, effective friction, or acoustic energy are called "events". The "critical event" is the earliest point at which coating removal is observed and its force level is the measure of adherence.

SAMPLE STYLOMETER PLOT



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