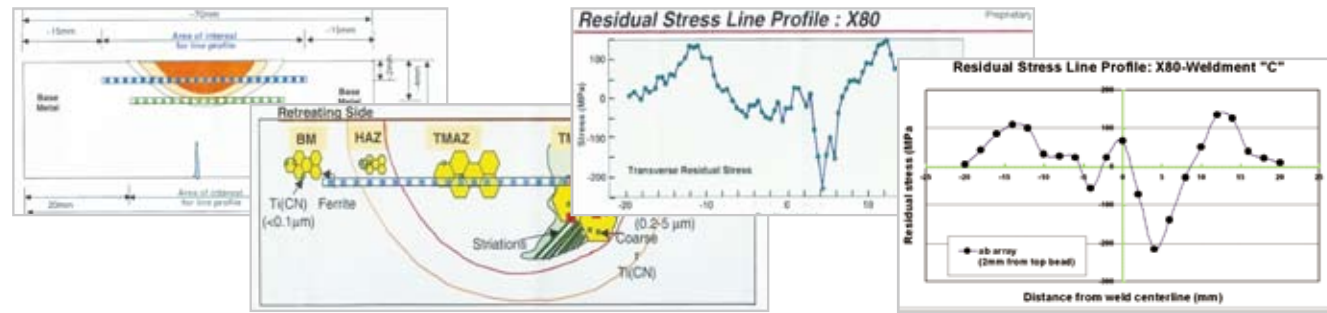


# AIS3000

Advanced Indentation System 3000



**Objective:** Evaluation of residual stress in accordance with welding method  
**Location:** ExxonMobil REC (2005) **Subject:** API X80 steel  
**Welding Method:** Friction Welding

### Purpose

The test evaluates residual stress at a friction-welded area and its perimeter. It was compared with the X-ray diffraction method, a non-destructive test method.

### Effect

Optimal test conditions can be achieved by evaluating properties of a specific weldment. Lifetime of a structure at an actual site can be extended by applying optimal conditions.

	Max. Residual stress	Min. Residual stress
X-ray Diffraction	230	150
IIT	215	136

### Features

While there was little difference between the two methods in test results, there was a significant difference in terms of measuring time.

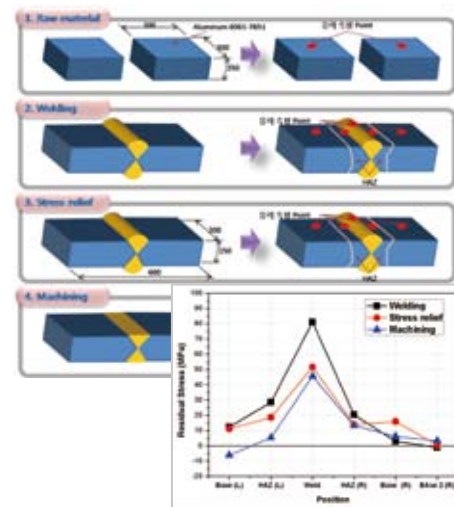
**Objective:** Evaluation of residual stress in accordance with welding method  
**Evaluation location:** Ju Seong Eng. (2010. 5) **Subject:** Al6061-T651

### Purpose

It's a test to evaluate changes of residual stress appeared when Al6061-T651 welding material goes through stress relief and surface process stage. As a result of the test, it can be known that lots of residual stress is relieved at the stress relief stage.

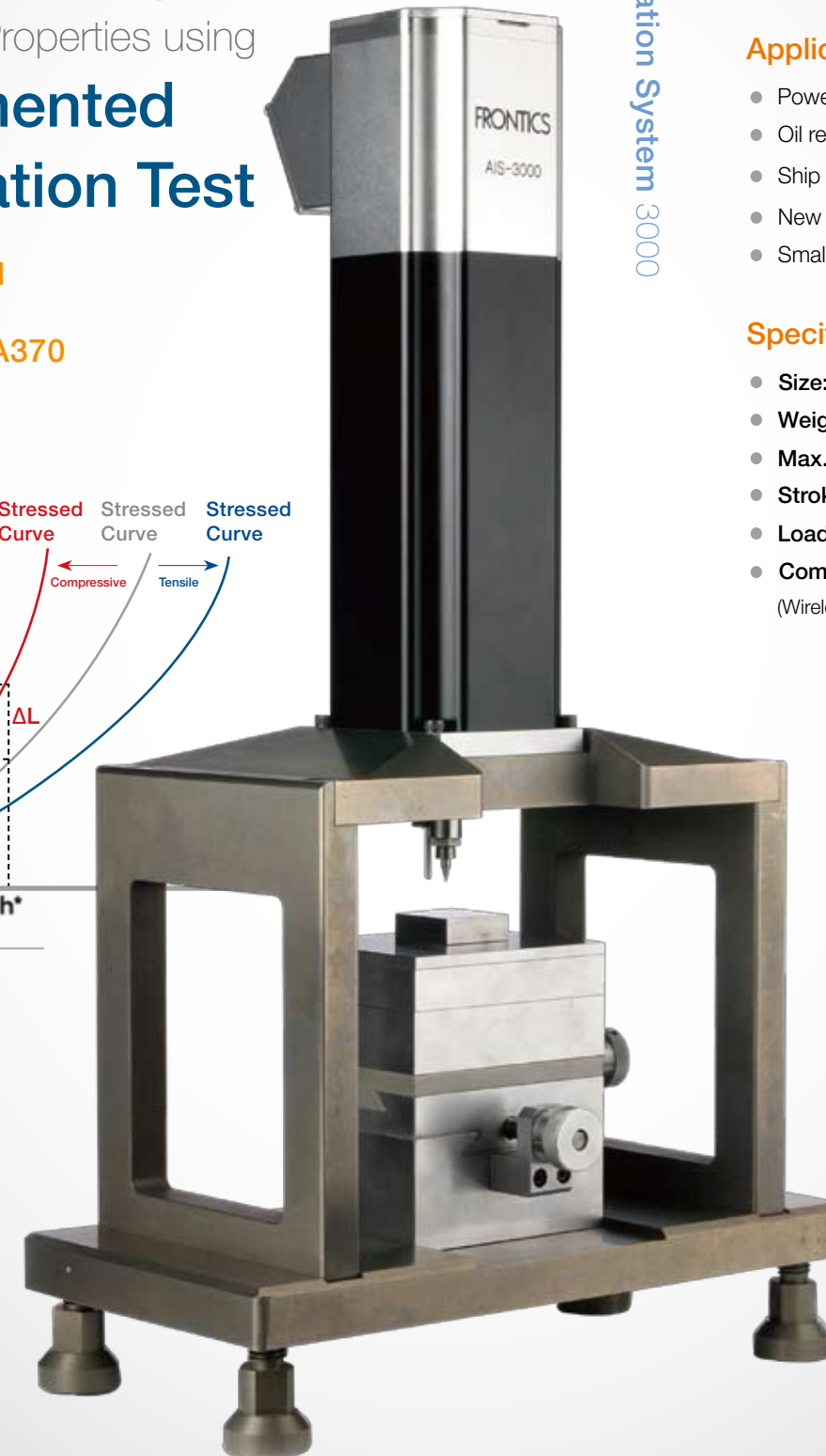
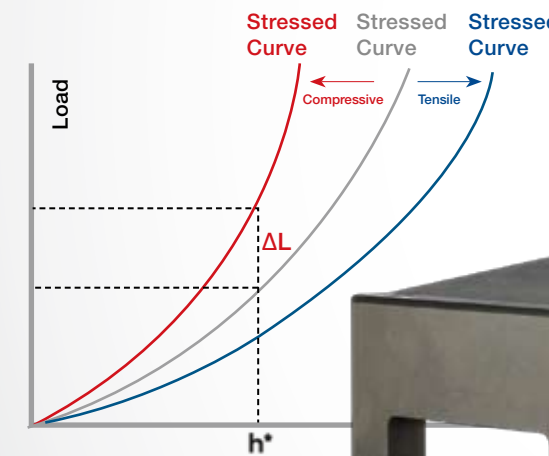
### Effect

The existing stress relief method is completed in laboratory aspect and can be changed by various effects at a field. To complement these points, the stability of a subject can be obtained by testing promptly at a field.



## Evaluation System for Tensile Properties using Instrumented Indentation Test

ISO/TR 29381  
 KS B0951  
 KEPIC MDF A370



Advanced Indentation System 3000

### AIS3000 Features

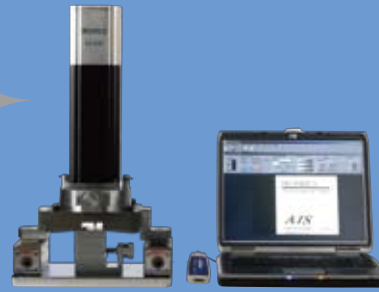
- Non-destructive evaluation of residual stress
- Direct test and evaluation at the site
- Simple composition: test equipment and analysis PC
- Automatic test and analysis

### Application field

- Power plant
- Oil refinery
- Ship building
- New materials
- Small and thin plate

### Specification

- **Size:** 180 x 180 x 430 mm
- **Weight:** 7 kg
- **Max. load:** 300 kgf (Res.: 5.6 gf)
- **Stroke:** 40 mm (Res.: 0.1 um)
- **Loading rate:** 0.05 ~ 30 mm/min
- **Communication:** RS-422 (Wireless - Bluetooth)



Indentation System for Evaluation of Residual Stress using Non-Destructive Method

# AIS3000



**Chain System**  
 · Applied to pipes with 6 ~ 40 inch diameter  
 · Applied to nonmagnetic material



**Magnet System**  
 · Applied to pipes with 10 ~ 48 inch diameter  
 · Applied to apply to plate shape as well  
 · Applied to apply to plate shape as well



**U-block System**  
 · Applied to pipes with 3 ~ 6 inch diameter



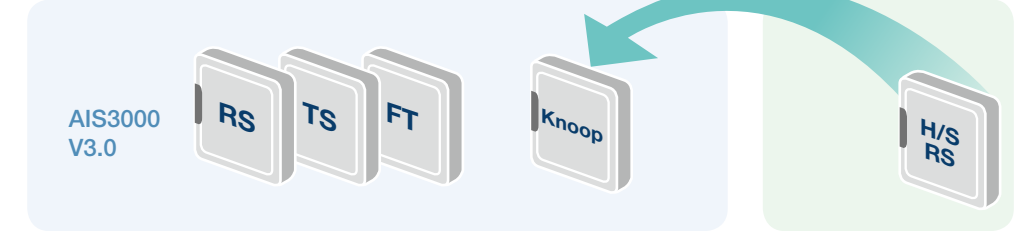
# AIS3000

# AIS3000

Advanced Indentation System



**AIS3000**  
**Indentation System**  
 for Evaluation of  
**Residual Stress** using  
 Non-Destructive Method



## AIS3000 Introduction

FRONTICS' AIS3000 V3.0 is software for new device types

Since the first introduction of AIS2000 V1.0 in 2000, the AIS software has evolved based on user opinions. Then AIS3000 V1.0 was introduced with an analysis module to analyze residual stress and fracture toughness. Our users wanted to evaluate residual stress and composition of multiple items, as well as fracture toughness. Accordingly, we introduced AIS3000 V3.0, which classifies residual stress as a basic analysis item and can add various other items for analysis.

### Features of AIS3000 V3.0

AIS3000 V3.0 classifies residual stress as a basic analysis item and evaluates tensile properties, fracture toughness and various other items

- Evaluates various items from a single device
- Minimizes inconvenient maintenance of V2.0 by using independent software for each evaluation item
- New items can be evaluated by adding corresponding software, without purchasing additional equipment

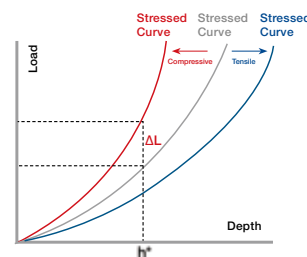
### Data Numbering Function

The Project function that was introduced in AIS3000 V2.0 was upgraded in AIS3000 V3.0

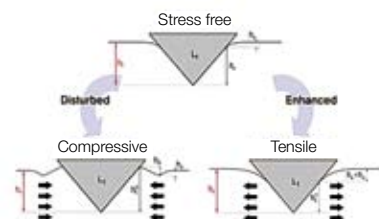
- Enhanced Project function by introducing Data Numbering
- When testing, moving, deleting and copying unnecessary or redundant data
- When analyzing, open the Project and batch processing
- Results of Project analysis can be used for creating databases and writing reports

## AIS3000 Design Principle

By comparing the difference between load-depth curves based on the presence of residual stress, it is possible to measure values with high accuracy and reproducibility. AIS3000 can also measure residual stress without damaging the test material, since it is indented with a depth of less than 100 μm.



$$\sigma_{res}^{//} = K \frac{\Delta L^{w,b}}{A_c}$$



### Advantages

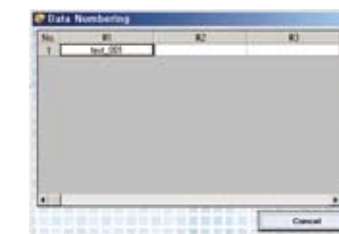
- Confirmation of the results immediately after the test
- Prompt and simple test using a wireless communication module between equipment and computer
- Can be operated on a light portable battery when commercial power supply is not readily available

## AIS3000 Technical Skills

AIS3000 applies ISO/TR29381, as well as Korean standards (KS B0950, KS B0951, and KEPIC MDF A370). IIT was newly developed in Korea and meets the Korean Standard of Residual Stress (2005), KEPIC code (2007) and ISO/TR (2008) that were established in 2000. Thanks to its ISO certificate, AIS3000 is drawing a great deal of attention from around the world.

### Advantages of IIT

- Allows on-site testing without damaging the subject, which is only indented by approximately 100 μm
- Simple test preparation and procedures even for novice operators



### What is Data Numbering?

Unlike the test plan, locations of preliminary tests, overlapping tests, and unnecessary tests are skipped in the actual test. However if this information is not identified in the software, there is the inconvenience of having to rearrange the analytical results. Data Numbering helps this by arranging the information in a table format.





# AIS2100

# AIS2100

Advanced Indentation System



## AIS2100

Indentation System  
to Measurement of  
**Tensile Properties** using  
Non-Destructive Method

**LCD Panel**  
For control and monitoring



**Power / Communication**  
Power : 110 ~ 220 V (Free volt.)  
Communication: RS-422/Bluetooth



**Actuator**  
Loading rate: 0.05 ~ 30 mm/min  
Full stroke: 40 mm



**Loadcell**  
Maximum load: 300 kgf  
Load resolution: 5.6 gf



**변위**  
Linear Scale  
변위 분해능: 0.1 um



**Indenter**  
Spherical Indenter (Dia. 0.5/1.0 mm)  
Vickers Indeter



## AIS2100 Design Principle

Designed for applications in laboratories and industrial sites, AIS2100 is small, light and portable, yet guarantees highly accurate measurement.

AIS2100 offers real-time measures of depth over continuous load and immediate on-site evaluation of various properties through AIS2100 software installed on the analyzer computer with load-depth curves. AIS2100 evaluates tensile properties very effectively for specimens that are difficult to manufacture because the test subject is small and has a complicated shape. Moreover, AIS2100 enables uniaxial tensile testing of materials with tensile properties that are unevenly distributed. AIS2100's light weight makes it easily portable for on-site experiments, and it uses a strong adhesive device to prevent Causing damage to subjects of various shapes.

### AIS2100 Hardware Features

#### High Accuracy and Reliability

- Enables tests within various ranges with high resolution using a high-capacity loadcell
- Allows adjustments in 0.1 μm units using linear scale for accurate testing

#### Enhanced User Convenience

- USB system connection
- Wired or wireless communication and control modules
- Control and analysis from laptop computer with dedicated software
- Can be operated with portable battery (up to 10 hours)

#### Convenient and Stronger Adhesive Device

- Wide dovetail slider enables multiple experiments with single installation
- Highly portable for quick and easy installation

## AIS2100 Instrumented Indentation Test (IIT)

IIT as domestic standards including KS B0950, KS B0951, and KEPIC MDF A370.

IIT was newly developed in Korea and meets KEPIC code 2007 and ISO/TR 2008 that were established in 2000. Thanks to its ISO/TR certificate, IIT is drawing a great deal of attention from around the world.

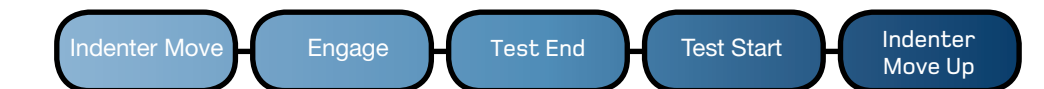
### Range of Properties Evaluation with IIT

- Applies to metals such as general carbon steel, aluminum alloy, SUS series and high-strength steel
- Classified into four groups (Type 1 ~ Type 4) to enhance the accuracy of results
- Allows on-site testing without damaging the subject, which is inserted with a pressure of approximately 150 um
- Simple test preparation and procedures even for novice operators

## AIS2100 V3.0 Software

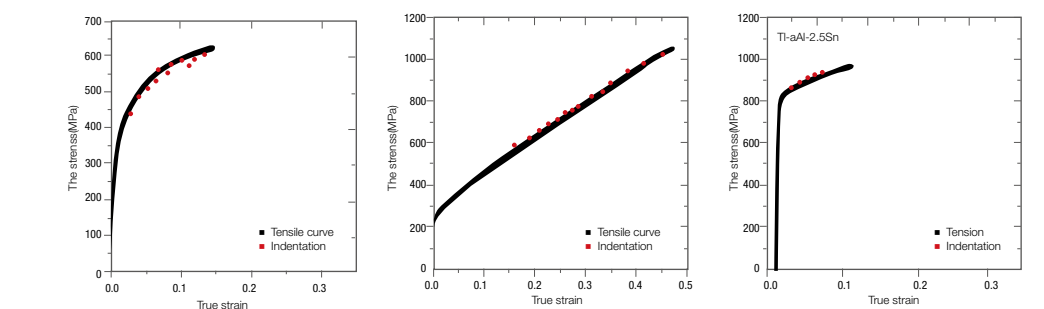
### User-friendly Software

- Reduced Test Steps: Existing 6-step test sequence is reduced to 5 steps
- Test procedures are controlled according to a preconfigured sequence, minimizing potential errors that can be caused by an inexperienced user
- Unnecessary options removed: Tautological parts were removed from automatic application of basic and repeated test conditions.



### Comprehensive Analysis

- More types of subjects can be analyzed, including BCC-type metals (Type 1), FCC-type metals (Type 2), high-strength materials (Type 3) and user-defined materials (Type 4)
- **Some analysis options were removed:** Now analysis is performed based on the selection of materials by applying the IIT theory that is necessary to classify materials based on analytical results
- **Multi-file analysis:** Batch processing of multiple sets of data obtained from repeated tests
- **Suggestion of methods for material classification for on-site and novice user:** Direct and indirect identification using magnetic method and test data, respectively



### All-in-One Software

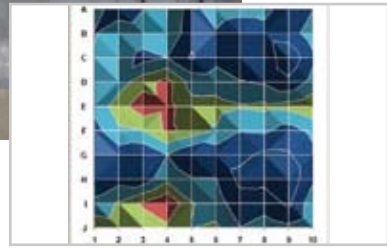
Includes functions for testing, analysis, database, and creating reports

- Facilitates novice users by minimizing the test operation
- Swift on-site operation based on batch processing of multiple sets of test data
- Allows user to create database and write a report regarding test results
- Prompt comparison of test data and analytical results



# AIT-U

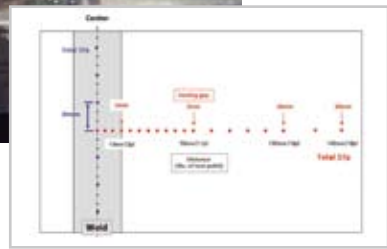
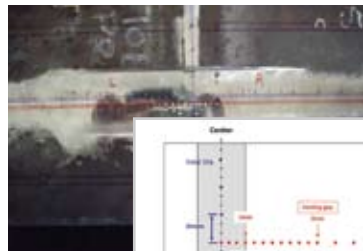
Advanced Indentation Tester-U



**Objective:** Identification of inclusion within Mg plate  
**Location:** RIST **Subject:** Mg plate

### Purpose

In order to identify the inclusion of newly developed Mg plates, single and multiple series of automatic tests were conducted by easily mapping test subjects



**Objective:** Evaluation of compatibility of welding part of Cr steel  
**Location:** AlCoa (Australia) **Subject:** Welding parts of Cr steel

### Purpose

Properties evaluation was conducted to assess the compatibility of weldment between two Cr steel plates in V-groove form. Automatic testing was conducted for 37 test locations for one line.



**Objective:** Evaluation of properties of welding parts of T23 boiler tube  
**Location:** KEPCO Research Institute **Subject:** Welding parts of T23 boiler tube

### Purpose

The properties evaluation of weldment was conducted for subjects with different heat treatment conditions of over T23 boiler tubes that are widely used at thermal power plants. Automatic testing was conducted for one line, including weldment, because the height of each test location was different.



## One Touch, Full Automatic Test Indentation Equipment for Evaluation Tensile Properties

**KS B0950**  
**ISO/TR29381**  
**KEPIC MDF A370**



Advanced Indentation Tester-U

### AIT-U Features

- Non-destructive tensile properties evaluation
- Maximizing human efficiency with the application of automatic/repeated test method
- Convenient operation through LCD touch panel
- Securing of sight using LED lighting
- Automatic transfer of X-Y-Z axis
- Possible to control using Jog shuttle
- Self-checkup and revision system mounted
- Exclusive model for laboratory

### Specification

- **Size:** 600 x 500 x 1400 mm (220 kg)
- **Max. load:** 200 kgf (Res.: 5.6 gf)
- **Stroke:** 40 mm (Res.: 0.1 um)
- **Loading rate:** 0.05 ~ 30 mm/min
- **Communication:** RS-422
- **Control:** LCD Touch panel

### Items

- Yield strength
- Tensile strength
- Elastic modulus
- Work hardening component
- Vickers hardness



Indentation  
Equipment for  
Evaluation  
Tensile Properties

## AIT-U



**Control PC**  
 · Touch LCD monitor adopted



**Automatic moving system**  
 · Simple and accurate test location control



**Convenient operation**  
 · Proceeding a test using a separate jog shuttle





### AIT-U

**Exclusive Laboratory Test Equipment for Measuring Tensile Properties**



#### Specification

Model	AIT-U	
Size	600 x 500 x 1400mm(220kg)	
Max load	200kgf	
Resolution(load/depth)	5.6gf/0.1 $\mu$ m	
Full stroke	40mm	
Loading rate	0.05-30mm/min	
Communication	RS422	
Data acquisition rate	100 point/sec	
Power	Adater	AC110-220V(free voltage)
Analyzing Computer	Basic	LCD touch panel computer
Indenter	Spherical indenter	
	Sharp indenter(Optional)	



#### New Laboratory Test Equipment

AIT-U (Advanced Indentation Tester-U) is exclusive laboratory test equipment for measuring tensile properties and Vickers hardness. Fully automatic test functions and self-diagnostics allow convenient operation. The AIT-U unit contains the indentation module and the control PC for installation in a limited space.

#### AIT-U Features

##### User-friendly hardware

- The control PC is integrated with AIT-U
- Convenient operation from the LCD touch screen panel
- LED lighting provides high visibility
- Automatic transfer functions of X, Y, and Z axes
- Jog shuttle control
- Observation of specimens through the Vision system (Optional)
- Easy to store and requires little space
- High quality exterior design

##### Convenient software

- Simplified menu design
- Automatic functions for quick test procedures
- Optimized for touch screen application
- Simplified procedures from 'Test' to 'Report' Self-diagnostics system



#### AIT-U Functions

##### Fully Automatic Test

- System application for increased efficiency in the laboratory environment
- Fully automatic testing using systems and sensors
- A single push of a button starts automatic procedures consisting of tests and analyses, and creating reports
- Automatic/repeated tests on same test subjects (Maximum 99 times)
- Automatic height measurement according to test locations and automatic test condition setting

##### All-in-One Software (AIT-U V1.0)

- Includes functions for testing, analysis, database, and creating reports
- Acquiring and comparison of real-time test data from load displacement
- Analysis method based on the tensile properties evaluation theory and the indentation test method
- Saves analytical results adjusted to various conditions
- Save and print analytical results adjusted to a report format (Excel file)
- Identification of test locations using the Vision system (Optional)

##### Self-Inspection System

**A series of automatic diagnostic procedures for inspecting and adjusting sensors, and checking equipment status to obtain optimal data**

- Load cell calibration
- Laser sensor setting
- Equipment inspection using Spherical indenter
- Equipment inspection using Vickers indenter



#### Touch Screen System

Allows direct operation without a keyboard or a mouse

**Touch Type:** Decompression Type  
**Touch Screen**  
**LCD size:** 15 inch  
**Resolution:** 1024 x 768



# Micro AIS Micro Indentation Measurement

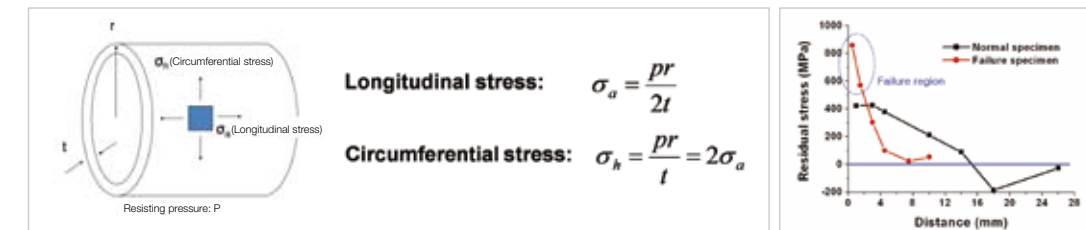
## Failure analysis of fine copper tube

### Purpose

The test was designed to evaluate the cause of damage on a refrigerant container and its tube joint part. The cause was identified based on comparison of the damages from the heat generated in the process of silver brazing the container and the tube.

### Results

Test results indicated that the residual stress on the damaged container had sharply increased compared to that of other containers (undamaged ones)



**Purpose:** Failure analysis of copper fine tube **Location:** LG Electronics (2006. 4)  
**Object:** Copper fine tube and vessel **Welding method:** silver brazing

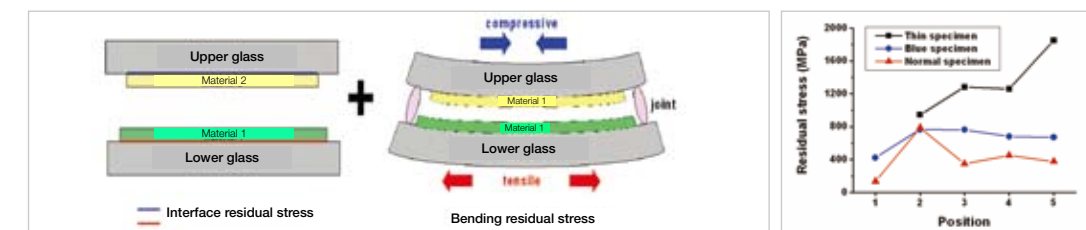
## Failure Analysis of PDP Glass

### Purpose

The test evaluated the residual stress of the three types of PDP glass manufactured with different processes and thicknesses. The test was intended to yield optimal manufacturing conditions by comparing the residual stress of the glass for which thickness was varied, and another type of PDP glass whose surface was treated to meet commercial quality standards.

### Results

Residual stress on both types of PDP glass increased sharply.



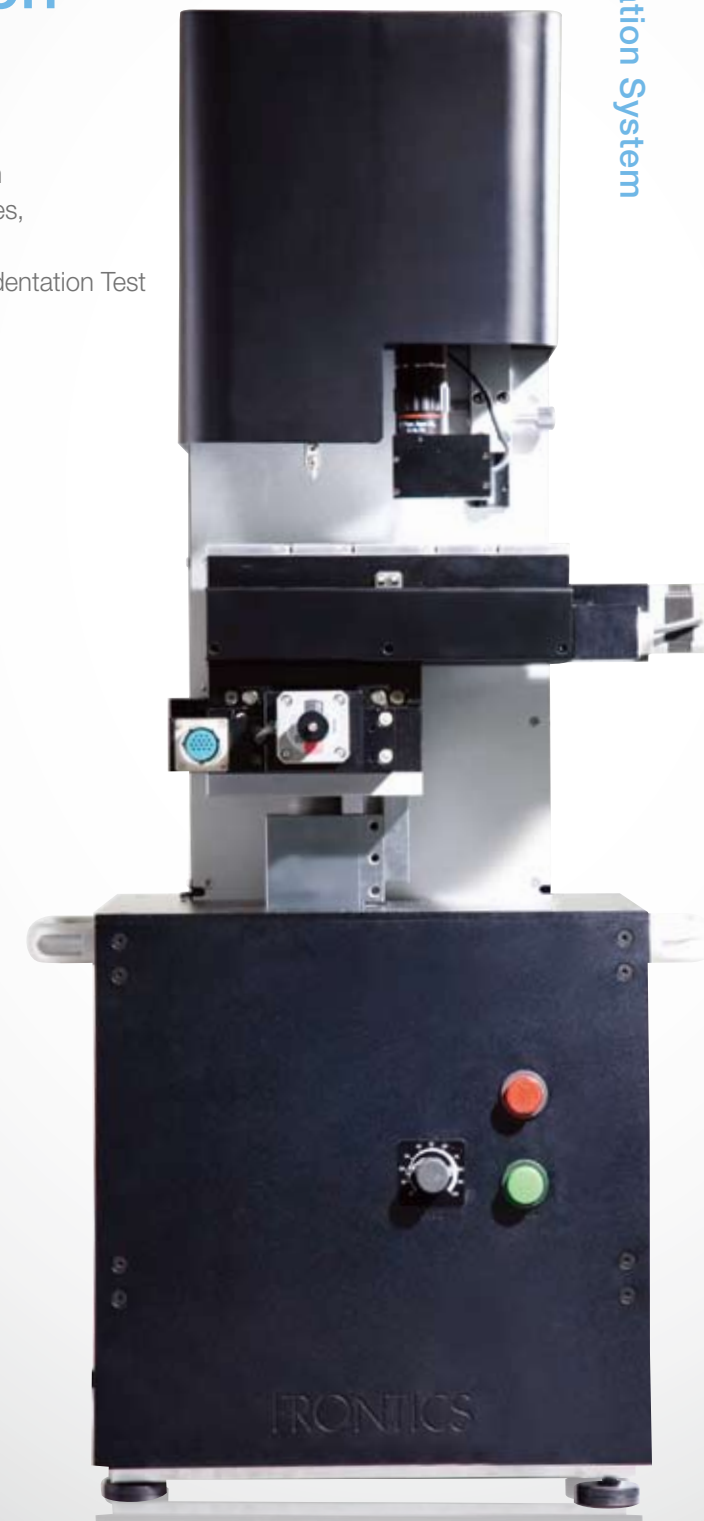
**Purpose:** Evaluation of residual stress of the three kinds of PDP glass  
**Location:** SAMSUNG Electronics (2007. 8) **Object:** PDP glass



# Micro Advanced Indentation System

**Test range:** scores of um  
**Analysis:** Tensile Properties, Residual stress  
**Method:** Instrumented Indentation Test

**ISO/TR 29381**  
**KS B0951**  
**KS B0950**  
**KEPIC MDF A370**



Micro Advanced Indentation System

### Characteristic

- Evaluation of Residual stress using IIT
- Quantitative analysis
- User-friendly Interface
- Automatic Moving System
- Vision System

### Application

- General hard coating layer
- Protective coating layer on glass
- Sol-resistant coating layer
- Coating layer of electronic material
- Thin film

### Specification

- **Size:** 328 X 305 X 900 mm
- **Max. load:** 2000 gf (Resolution: 10 mgf)
- **Stroke:** 15 um (Resolution: 10 nm)
- **Vision:** X1500, Digital Camera, Image SW
- **Analysis:** Tensile Properties, Residual Stress
- **Test range:** scores of um
- **Method:** Instrumented Indentation Test



Micro Advanced Indentation System

# Micro AIS



### Vision system

- Applied to vision system of non-contact type



### Automatic moving system

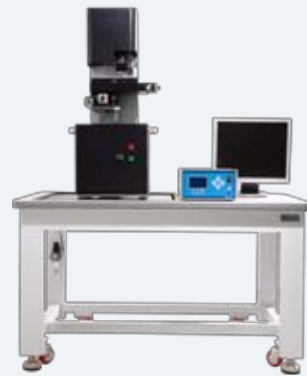
- Easy and accurate position control



### Auto Test

- Increase convenience through auto and repeat test





## Micro AIS

Micro AIS is instrumented **indentation test equipment** for evaluating **residual stress** and **Vickers hardness** of objects in the micrometer range

## Micro AIS

Micro AIS evaluates tensile properties and residual stresses of the test subjects of very small dimensions (micrometers), such as fine-welded parts and coated layers. Through the Vision system and automatic stages, the test position can be identified and designated. Moreover, precision test for major parts is made available through automatic and screening tests.

### Items

- Micro Vickers Hardness (Max. load 2000 gf)
- Residual Stress
- Yield strength
- Tensile strength
- Elastic modulus

### Specification

Model	Micro AIS
Size	328 X 305 X 900mm
Max. load	2000 gf
Load resolution	0.01 gf (10 mgf)
Depth resolution	0.01 um (10 nm)
Stage	X-Y axis stage, Z axis stage
Operating Temp.	-10°C ~ 40°C
Power	220Vac
Vision	X1500, digital camera, image SW
Indenter	Micro Vickers indenter Dia.0.05mm spherical indenter
Used	Evaluation of residual stress (Micro range)



## Micro AIS Introduction

### Features

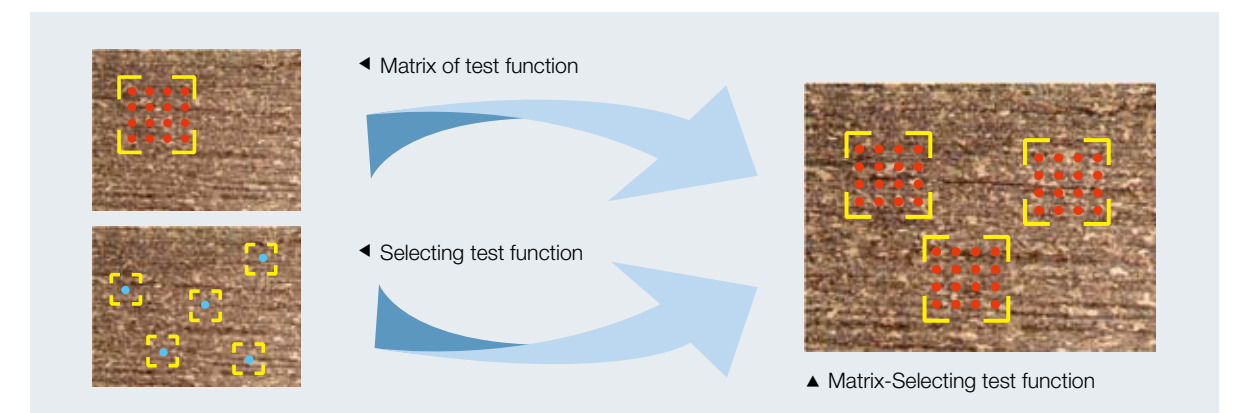
- **Perfect implementation of IIT in the micrometer range**
  - Application of ISO/TR 29381 in the micrometer range
  - Application of KS B0950 and KS B0951 technology
  - Application of IIT eliminates human errors
- **User-Friendly software**
  - Easy to use Window-based software
  - Evaluation of the tensile properties and residual stresses is made available immediately after the test
  - User convenience has been enhanced with automatic malfunction checking and data error inspection



### Multi-point testing system

#### Implementation of automated testing based on the Automatic Moving system and the Vision system

- Tests can be automatically completed with an initial setup of test conditions
- Maximum efficiency of personnel and time through repeated testing
- **Matrix test function:** Test procedures for selected image ranges
- **Selecting test function:** Test procedures for randomly selected positions
- **Matrix-selecting test function:** Test procedures for various randomly selected locations in checkerboard format



### Automatic moving system

- Enables fine positioning and adjustment
- For precise controlling and automatic testing
  - **System:** X, Y Stage
  - **Resolution:** 1 um
  - **Moving rate:** 1 ~ 30 mm/min

### Vision system

- Enables fine positioning and adjustment
- For precise controlling and automatic testing
  - **Magnification:** X150 (Max.: X1200)
  - **Max. Distance:** 100 mm
  - **Saving type:** Digital image capture



# AIS3000 COMPACT

Advanced Indentation System 3000 Compact



## Evaluation of residual stress of Natural gas pipeline

**Object:** Evaluation of residual stress in accordance with ground settlement  
**Location:** Korea Gas Safety Corporation (2009.5) **Subject:** API X52

### Purpose

Stress concentration occurred on city gas pipeline due to ground settlement. The residual stress was evaluated on major parts where stress was concentrated.

### Features

AIS3000 Compact was deployed for testing in small spaces with enhanced on-site efficiency using UMPC.



## Evaluation of tensile properties of Rotor Groove

**Object:** Evaluation properties of Rotor groove  
**Location:** Boryung Thermal Power Plant (2009. 8) **Subject:** Turbine Rotor HP

### Purpose

Properties were evaluated on vulnerable groove rotor parts of a power plant. Since it was difficult to deploy ordinary equipment due to the size of the subject, we used AIS3000 Compact to perform evaluation and testing with an exclusive jig manufactured for the specific shape of the subject.

### Features

The test results were used for lifespan evaluation according to client's request.



## Evaluation of tensile properties of Turbine casing

**Object:** Evaluation of Properties of Turbine casing  
**Location:** Dangjin Thermal Power Plant (2009. 6) **Subject:** Turbine Rotor Casing

### Purpose

Properties of major parts of a turbine casing were evaluated at a power plant. The tests were conducted based on direct evaluation because there was insufficient space surrounding the turbine casing.



# Evaluation System for Residual Stress using Instrumented Indentation Test

More Compact,  
More Powerful



Advanced Indentation System 3000 Compact

### Compact equipment

- **Size:** 80 x 80 x 295(h) mm
- **Weight:** 3.5 kg
- **Max. load:** 100 kgf (Resolution: 2.5 gf)
- **Stroke:** 25 mm (Resolution: 0.1 um)
- **Communication:** RS-422 / Bluetooth

### Powerful Functions

- Non-destructive residual stress evaluation
- Optional tensile properties device
- Seamless integration with IIT
- Application of ISO / TR29381
- Application of KS B0950 / KS B0951 (Korean standards)
- Application of KEPIC MDF A370 code

### Portability

- Simple composition: Test equipment and an analysis PC
- Wireless communication based on a Bluetooth module
- Uses UMPC for convenience and portability
- AIS3000 Mini software for UMPC and a touch-screen module



Indentation System  
for Evaluation of  
Residual Stress using  
Non-Destructive Method

# AIS3000 COMPACT



### Wireless communication

- Bluetooth module for convenience on site
- Possible to communicate with in 100 m



### Compatibility of attachment

- Compatibility of AIS3000 attachment



### UMPC

- 5 inch / Touch-screen type



# AIS3000

# COMPACT

# AIS3000 COMPACT

Advanced Indentation System



## AIS3000 Compact

Indentation System for evaluation of Residual Stress using Non-Destructive Method



### More Compact

AIS3000 Compact maximizes portability for on-site applications.

AIS3000 Compact features size and weight 50% less than AIS300, but with enhanced functionality for easy on-site measurement of residual stress and tensile properties. Using the wireless communication module, dedicated UMPC, and lightweight battery, tests can be performed even in small spaces where commercial power supply is not available.

### Items

- Residual Stress
- Yield strength
- Tensile strength
- Elastic modulus



Model	AIS 3000 Compact
Size	80 X 80 X 295 mm
Weight	3.5 kg
Max. load	100 kgf
Load resolution	2.5 gf
Stroke	25 mm
Depth resolution	0.1 um
Operating Temp.	-10°C ~ 40°C
Power	220Vac
Indenter	Vickers indenter Dia.0.5mm spherical indenter
Used	Evaluation of residual stress, Tensile properties

## AIS3000 Features

### Seamless Integration with Instrumented Indentation Test (IIT)

Instrumented Indentation Test (IIT) is a new technology meeting various standards and certifications, including ISO/TR29381, KS B0950, KS B0951(Korean standards) and KEPIC MDF A370. Integration of IIT and AIS3000 V3.0 allows various forms of on-site evaluation.



- Evaluation of residual stress and tensile properties using IIT
- Prompt on-site evaluation using a non-destructive method
- Application of AIS3000 V3.0
- Exclusive mini software for AIS Compact
- Convenience and portability by using UMPC



### Enhanced On-Site Convenience

#### Convenience and portability

- 5-inch UMPC
- Ultra-light weight of 400 g
- Simple operation based on a touch screen



#### Exclusive miniature software (AIS3000 Mini)

- Window-based GUI
- Optimal screen composition for simple operation
- Perfect test data compatibility with existing software

### Equipment Organization according to User Demands

- Can be transformed into specific sizes in accordance with test subjects
- Can be manufactured exclusively to be attached to unique shapes



▶ UMPC and site images showing its applications



▶ Independent interface and main frame allow operation in small spaces



▶ Testable exclusively attached to the Rotor Groove