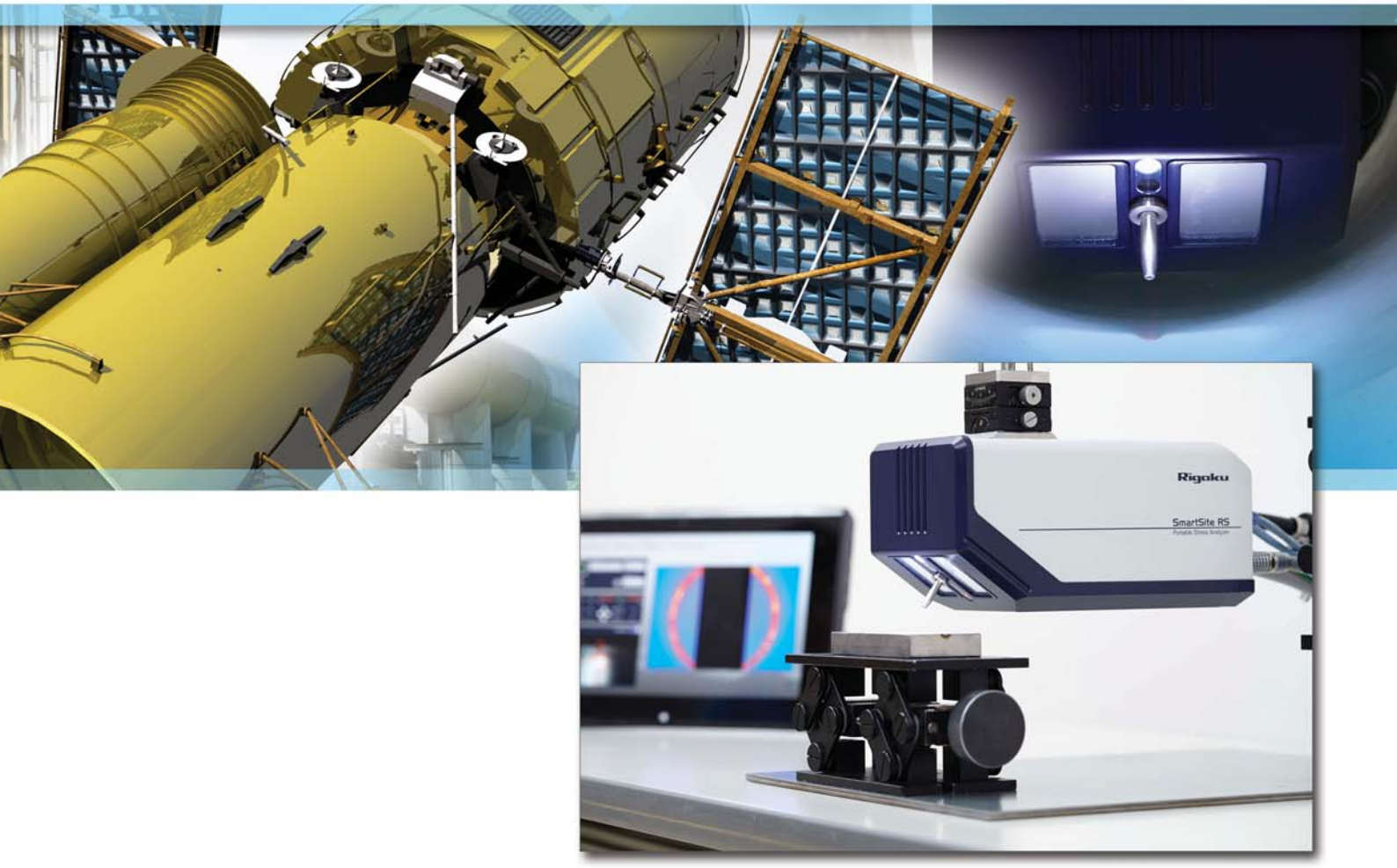
SmartSite RS

Field X-ray instrument

Portable stress analyzer



Rigaku

Better measurements. Better confidence. Better world.

The World's Smallest Stress Analyzer

SmartSite RS

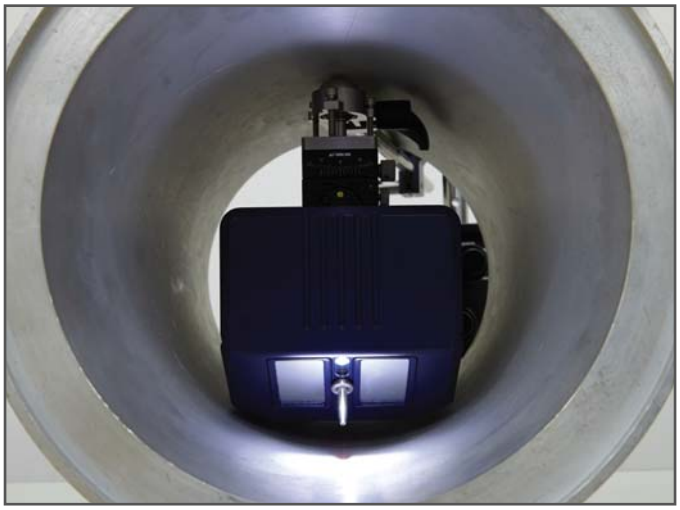
Head unit(bottom right)
Power supply unit (back)
Tablet PC for operation (bottom left)

†As of August 2014

Unique Features

The world's smallest instrument design

The world's smallest measurement head is 114(W) x 248(D) x 111(H) mm and weighs 3 kg. It enables measurement of residual stress in the inner surface of 200 mmϕ pipe.

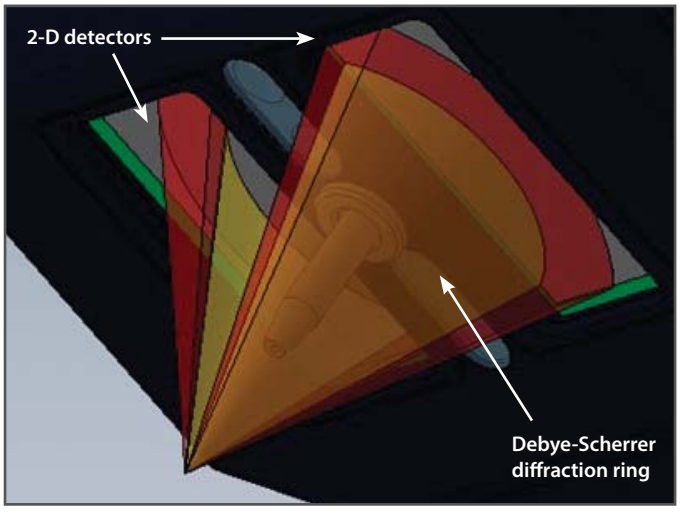


Remote operation through a tablet PC and Wi-Fi

The instrument is remotely controlled by a tablet PC with Wi-Fi communication.

Rapid data acquisition

A high-speed 2-dimensional semiconductor detector and single-exposure method accelerates data acquisition. Residual stress is measured in 60 seconds or less in most cases.



Built-in utilities

The instrument is powered by an optional exchangeable battery. There is no need to have utilities in field, e.g. cooling liquid and electricity.

Application Examples

Residual stress measurement on shot peened steel

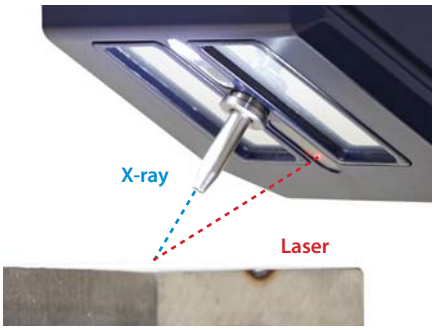


Figure 1. Arrangement of head unit and sample

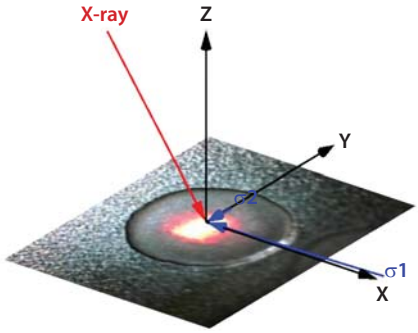


Figure 3. Stress principal axes (σ_1, σ_2) and sample coordinate (X, Y)

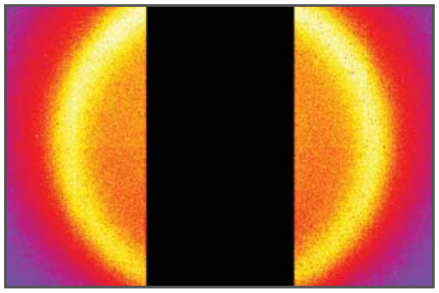


Figure 2. A 2-D Debye-Scherrer diffraction ring of α-Fe *211* diffraction

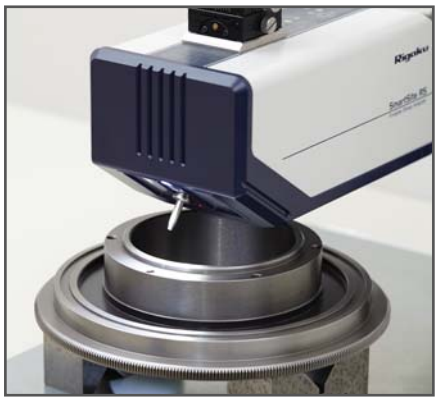
Stress tensor σij, MPa	
σ11	-1278.9 ±94.2
σ22	-235.8 ±1044.6
σ12	-46.1 ±40.9
Principal stress, MPa	
σ1	-1280.9
σ2	-233.7
Orientation angles, deg	
	σ1 σ2
X	2.5 87.5
Y	92.5 2.5
Parameters	
FWHM, deg	5.97 ±0.99

Figure 4. Residual stress analysis result

The shot peening process creates high residual stress at the peened area. A shot peened steel sample was aligned by monitoring an image displayed on a tablet PC as recorded by an integrated CCD camera with the aid of a laser marker (See Figure 1 and the next page for sample alignment details). Predefined material and measurement parameters were used for evaluation. A Debye-Scherrer diffraction ring of α-Fe *211* was recorded by the 2-dimensional semiconductor detector (Figure 2). Exposure time was 60 seconds. Principal stresses σ_1 and σ_2 were calculated and displayed with the sample image taken by the CCD camera (Fig. 3). Residual stress σ_{11} and its share component σ_{12} were calculated as -1278.9 and -46.1 MPa, respectively (Fig. 4). These data, including the sample image and Debye-Scherrer diffraction ring, are stored and summarized in a report.

Sample type

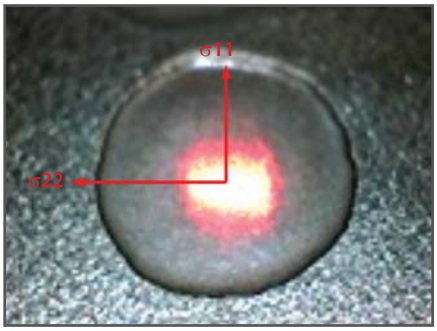
Typical sample types for residual stress measurement are summarized in the table. Other steel samples can also be measured. The sample shape is arbitrary: thanks to the device's compact design, sheets, bulk materials, springs, gears and pipes can be measured without major sample preparation.



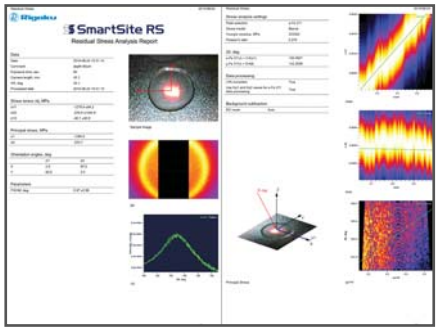
Examples of sample type	
Shot peening	
• Multistage shot peening	• Warm shot peening
• High-hardness shot peening	• Stress shot peening
• Fine shot peening	
Plastic working	
• Casting	• Pultrusion
• Extrusion	• Machining
• Rolling	• Pressing
General heat treatment	
• Hardening	
• Annealing	
Surface heat treatment	
• High-frequency hardening	
• Carburizing	
Welding	
Grinding and polishing	
Surface reforming	
Maintenance of plant and infrastructure	

Easy Alignment and Measurement

CCD sample observation camera and laser marker

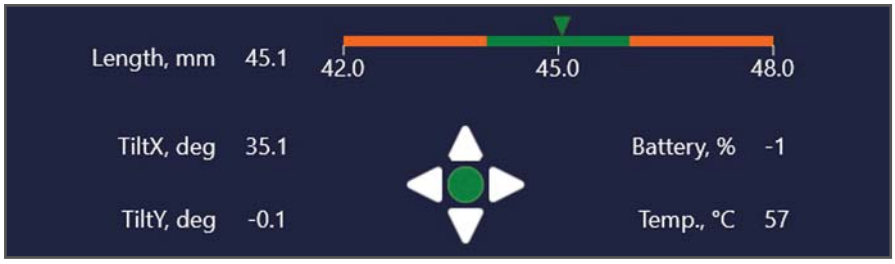


The measured point on the sample surface is indicated by a laser marker and is displayed on the tablet PC. White LEDs illuminate the sample for low-light work environments, e.g. inside a pipe. Sample image is stored together with measurement data and attached to the report.

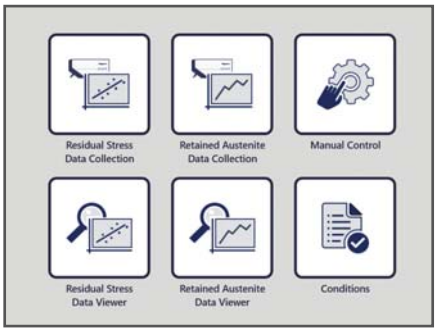


Sample alignment using sensors

The distance to the sample surface and the incident angle of the X-rays are measured by a laser displacement sensor as well as 3-dimensional (3D) accelerometer and displayed on the tablet PC. An operator is able to adjust these parameters easily by following indicators on the display.



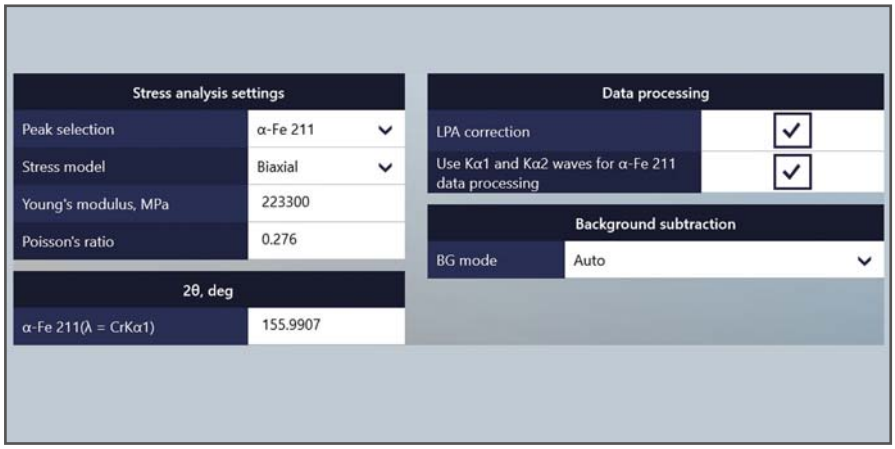
Single-click measurement and analysis



Measurement setup is easy. For daily use, the operator simply selects the type of application on the tablet PC and carries out the measurement. From data collection to reporting, all of the procedures are done by single-click operations.

For the expert user, detailed measurement and analysis conditions are editable through the instrument control software. An expert user can also edit material parameters in recipes for residual stress calculation.

Material-related parameters for each phase (e.g., Young's modulus, Poisson's ratio, Bragg angle of diffraction) are pre-installed in the instrument control software. Options for the residual stress calculation are select-able with regards to stress model, LPA (Lorentz-polarization and absorption) correction, wavelength component and BG (background) mode. Those parameters are saved as recipes to-gether with measurement conditions.



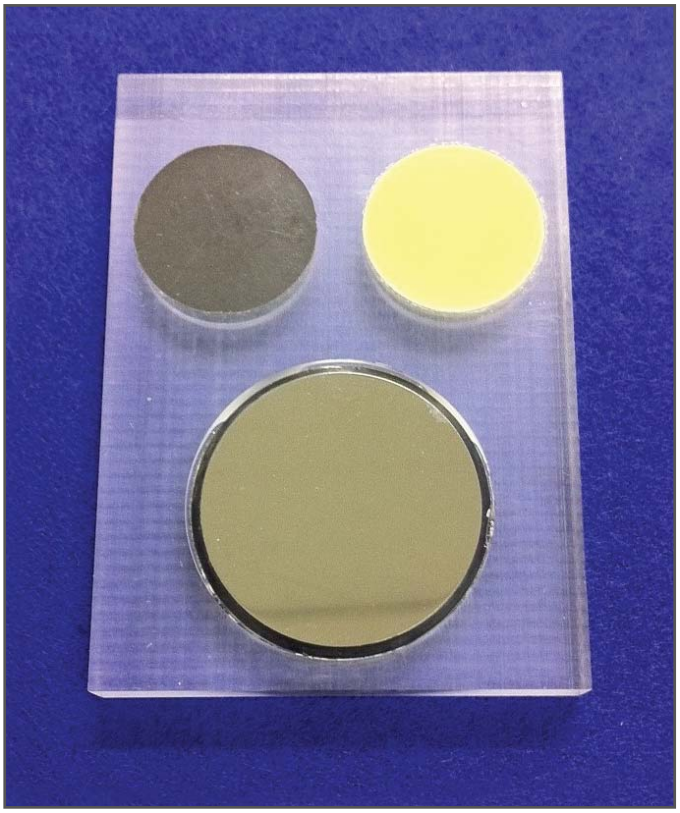
Safety and Traceability

Safety is our top priority

This portable device is designed for field analysis, and can be used in open space environments. Integrated laser displacement sensor and three-dimensional (3D) accelerometer measure distance to the sample and the position of the device. Unless those parameters are set properly, X-rays cannot be illuminated onto the sample. The multiple step safety algorithm protects the operator from exposure to radiation.

For indoor laboratory use, an optional radiation enclosure is available. It ensures a safe operational environment in the laboratory.

Calibration standards for measurement traceability



Measurement traceability is maintained by means of periodic calibration. SmartSite RS is delivered with instrument calibration standards, including steel powder, bulk steel and fluorescence powder. The steel powder calibrates "zero" stress and the absolute scale of residual stress is ensured by measuring the bulk steel sample, which has approximately -100 MPa of residual stress. Location and size of the X-ray spot on a sample is determined using the fluorescence powder standard.

Date: Tuesday, June 24, 2014

Comment: bulk

Date	Comment	σ11	σ12	FWHM
2014-06-13 15:14:06	powder	-6.1	5.5	1.5
2014-06-13 13:16:13	gear	-1094.4	-75.7	6.3
2014-06-13 12:28:09	gear-s-btm2	-250.9	-46.4	5.1
2014-06-13 12:25:32	gear-l-btm2	-129.9	-50.4	4.7
2014-06-13 12:18:33	gear-l-btm	-1269.2	-107.8	6.9
2014-06-13 12:16:04	gear-s-btm	-1087.5	39.0	5.9
2014-06-13 11:52:54	gear-L	-1744.1	-165.9	6.5
2014-06-13 11:50:06	gear-s	-1686.6	-7.6	5.5
2014-06-13 11:45:59	bulk	-149.4	-7.3	1.6
2014-06-13 11:45:03	bulk	-161.3	-7.2	1.6
2014-06-13 11:36:52	powder	-1.7	-3.6	1.5

Calibration records can be recalled at any time from the history view. This assures the measurement traceability of the instrument.

Specifications

Dimensions	
Head unit (excluding ball joint)	114 x 248 x 111 mm, 4.5 x 9.8 x 4.4 inch (W x D x H) approximately 3 kg, 6.6 lbs
Power supply unit	230 x 470 x 460 mm, 9.1 x 18.5 x 18.1 inch (W x D x H) approximately 20 kg, 44.1 lbs
High voltage cable	5 m
Storage for transportation	1x carrying case included

Residual stress measurement	
Materials to be measured	Steel, aluminum (optional)
Residual stress calculation	General equation (Rigaku original)
Stress component	Biaxial stress
X-ray tube	Chromium radiation (Cr), 30 kV - 50 W
X-ray incident angle	35°
X-ray beam size	1 mmϕ (with collimator), 2 mmϕ (without collimator)
Measurement time	approximately 60 seconds
X-ray detector	High-speed semiconductor 2-dimensional detector
X-ray detector size	2x (38.5 x 19.3 mm)
2θ range	145° ~ 165°
Sample-detector distance	45 mm

Operation	
PC	Windows 8.1 tablet PC
Communication	Wireless (Wi-Fi)

Environment, Utility, Safety	
Environment	Dust resistance
Temperature range	-10 ~ +50°C with less than ±4°C fluctuation
Humidity range	1 ~ 70 % R.H. with less than ±10 % R.H. fluctuation
Power supply	AC 100 - 240V or optional built-in battery
Safety mechanism	Safety mechanism by three-dimensional (3D) acceleration and laser displacement sensors, emergency stop switch, safety key

SmartSite RS

Field X-ray instrument

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