ANALYSIS SYSTEMS
National Electrostatics Corp.

RC43 Ion Beam Analysis Endstation

The NEC ion beam analysis (IBA) endstation (model RC43) is a versatile accessory for Pelletrons or other ion beam accelerators. When combined with a Pelletron accelerator and associated ion source and beamline components, the IBA endstation provides a complete IBA system, offering automatic data collection.

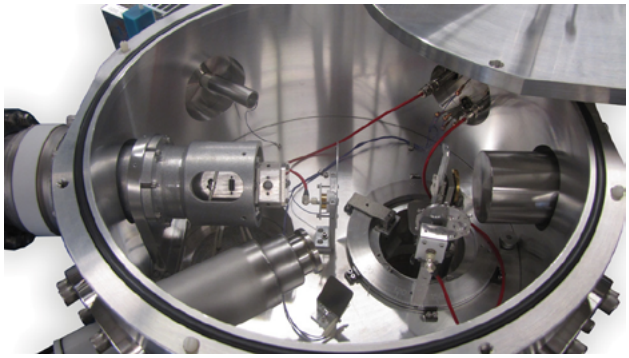
APPLICATIONS

Applications for thin film profiling and crystal defects are dominant with RBS and Channeling. With the addition of high depth resolution, mono-layer depth sensitivity of the near surface is available, specifically H profiling with ERD. Impurity information from PIXE give PPM levels of trace elements for art and archeology applications. Biomedical applications include ion beam genetic modification of seeds for disease resistance. External (in air) beam PIXE can be used to analyze cultural heritage and other sensitive samples. Chemical information is also available through Ion Beam Induced Luminescence. These are just some of the many applications of the analysis methods of which the RC43 endstation is capable.

The standard RC43 Endstation includes a particle detector for RBS analysis. Additional detectors can be added for ERD, NRA, PIXE, PIGE, and IBIL analysis. NEC also offers a microprobe for beam sizes of 20 microns and external beam capabilities. Please contact NEC for more details.

DESIGN

Target Chamber



Inside of chamber. In addition to standard components, this chamber also includes an X-ray detector, Gamma Detector, and Microprobe.

The scattering chamber is constructed primarily from aluminum with a 17” (43 cm) inside diameter and an 8” (20 cm) inside height. The base of the chamber provides stable support for the target manipulator, solid state particle detector, beam collimator, and turbo-molecular pump. The chamber lid is designed to limit its weight for ease of removal. A target load lock is placed in the lid to permit quick (less than 5 minute) changes of target holders while maintaining high vacuum. The chamber can accomodate up to 16 samples, 1cm x 1cm, side by side. The chamber is vacuum sealed with Viton O-rings and has a view port, target alignment laser, and video camera. The chamber is electrically isolated and can be used as a Faraday cup for precise beam current measurements.

Target Manipulator

The NEC RC43 includes a 5-axis Stepper Motor Driven Vacuum Generators Manipulator with a sample holder providing continuous rotation about the beam axis. The standard manipulator provides X and Y (horizontal) motion of +/-12.5 mm and Z (vertical) motion of +/-50 mm with resolution of 0.001 mm. Theta axis rotations (θ) (about vertical) of +/- 160° and Phi (φ) (about beam) is continuous, both having 0.01° resolution. All 5 axes of the manipulator are computer controlled. Local control is provided for efficient sample exchange between sample load lock and manipulator.

Current Integrator

A digital current integrator is provided to measure total ion beam current and provide gate signals for IBA measurements. The target chamber is electrically insulated from ground so that all ion current, including secondary electrons from the sample, are integrated. The incident beam collimator at the chamber entrance is insulated from the target chamber and the connection is brought out of the chamber for grounding or monitoring.

Pumps and Valves

A turbo-molecular pump with a minimum rating of 250 l/s for air and forepump with a minimum rating of 190 l/m are furnished to pump the target chamber and beamline near the chamber and the target load lock. Solenoid and pneumatic valves with appropriate controllers and gauges are provided to automatically pump out or vent the chamber. This system is interlocked to the turbo pump gate valve and the beamline gate valve so that these valves will close or open dependent on the vacuum status in the target chamber and the connecting beamline.

CONTROL AND DATA ANALYSIS

Sample positioning and data acquisition is computer controlled with Windows OS and NEC software. Digital pulse processing MCAs are incorporated to allow data collection and automated channeling analysis.

The RC43 Analytical Data Collection software performs qualitative analysis during data collection. Up to six (6) spectra can be gathered simultaneously, including RBS, ERD, NRA, and PIXE. The data is computer analyzed to yield a fast, verified, qualitatively complete real time materials analysis of the sample. To assist the operator performing crystalline or elemental mapping analysis, the software also prints plots of channeling and microprobe data.

The analytical system allows for automatic calibration of the theoretical model and automatic chi squared fitting of the model to the experimental data. Data may be presented either in depth profile format or various yield vs. energy formats. An element's surface scattering energy and height can be displayed. Peak thickness can be calculated and a peak can be plotted in atomic fraction vs. depth format. Up to 10 spectra can be plotted and overlaid with color and line styles automatically changed. Selective plots of individual elements can be done to separate overlapping data.

The RC43 control system also communicates with the accelerator control system itself, receiving beam energy information and sending instructions to produce the optimal beam conditions during real time runs. This automation also allows the entire system to be shut down at the end of a sample list.

OPTIONS

The standard RC43 Endstation includes a Silicon Surface Barrier detector of 50mm^2 area with a preamplifier and digital pulse processor for RBS analysis. Additional detectors available include:

ERD Particle Detector

NEC offers, as an option, an additional silicon surface barrier detector for ERD, or glancing RBS measurements. This option includes an insulated feedthrough with a support arm to allow movement of the detector from 30° to 170°. An ERD foil holder is also mounted on the support arm with positions for up to 6 different foil thicknesses. The electronics include the detector preamp, bias supply, and digital pulse processor.

Gamma Ray Detector

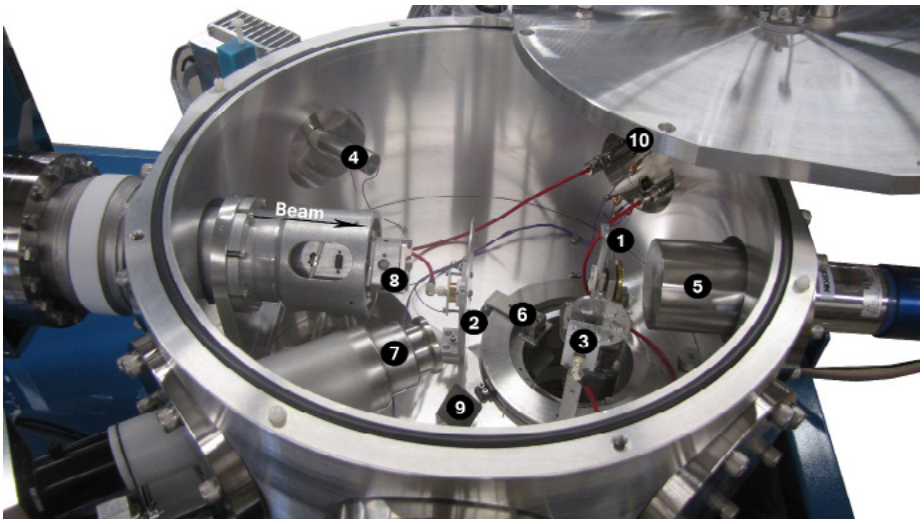
NEC offers, as an option, a 2" x 2" NaI(T1) Scintillation Detector, preamplifier, amplifier and high voltage bias power supply for NRA analysis. A reentrant tube allows the detector to be closely placed directly behind the target, allowing a large solid angle. A higher resolution HPGe detector is also available. Please contact NEC for more information regarding this detector.

PIXE Detector

NEC offers, as an option, a 25mm^2 Silicon Drift Detector (SDD) for PIXE analysis with a digital MCA. Also included are an X-ray filter holder, MCA with KLM lines, and necessary cables. Software setup and integration into RC43 software is included.

ACCESSORIES

NEC offers, as an option, a high resolution RBS detector system. This detector adds the capability of Ångstrom range depth profiling. Please contact NEC for further information regarding this detector system.



1. Sample
2. Fixed SSB at 170°
3. Moveable SSB and Filters at 180° to 30°
4. X-Ray Detector
5. Gamma Detector at 0°
6. X-Ray Detector Filters
7. Zoom Camera
8. Microprobe Lens
9. Light
10. Chamber Feedthroughs

SPECIFICATIONS

- RC43 System

Endstation:	54”L x 36”W
Console:	72”W x 24”D x 60” H

- Chamber

8” x 17” OD, Aluminum
(other chamber sizes available upon request)

Base Vacuum:	1 x 10-7 Torr
Operating Vacuum:	5 x 10-7 Torr
Number of Targets:	10/holder
Change Targets:	5 minutes
Number of Ports:	5 to 7 Radial
ERD Filters:	6
X-ray Filters:	4
Beamline Flange:	6” OD CF
Beam Collimation:	2.5mm to 0.5mm or MicroProbe Lens
Target Movement:	5 axis 100mm Z; 25mm X; 25mm Y, 320° Theta; Continuous Phi

- Software

Operating System:	Windows

- Power

Endstation:	30A, 110VAC
Console:	10A, 110VAC

- Compressed Air

80 psi

- Vent Gas

Dry Nitrogen 5cfm @ 5psi

- Rough Pump Vent

1” base, oil resistance

TECHNIQUES AVAILABLE

- Rutherford Backscattering (RBS)

Elemental composition, thin film thickness and depth profiling measurements

- High Resolution RBS*

Ångstrom level thin film resolution

- Channeling*

Crystal structure, purity, damage, and film alignment vs. substrate measurements

- Elastic Recoil Detection (ERD)*

Depth profiling of H and light elements with 10 PPM sensitivity (1H and 2H with He beam)

- Particle Induced X-ray Emission (PIXE)*

Trace elemental analysis with high sensitivity (0.1 to 10µg/gram)

- Particle Induced Gamma Emission (PIGE)*

Selective depth profiling of elements with enhanced sensitivity and resolution

- µPixe and µRBS*

Trace elemental concentration image of near surface region with 10 micron spatial resolution

- Nuclear Reaction Analysis (NRA)*

Selective depth profiling of elements with enhanced sensitivity using nuclear reactions

- Ion Beam Induced Luminescence (IBIL)*

Chemical bonding, crystal defects, and impurity information

** OPTIONAL. Additional detectors and related equipment needed for these techniques are available from NEC.*

Contact NEC

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