

Ferroelectric and Piezoelectric Evaluation Systems

Radiant Technologies, Inc. is the global leader in ferroelectric, piezoelectric, multiferroic, and magnetoelectric testing solutions. Our advanced test systems are trusted by researchers and engineers worldwide, driving innovation in memory devices, sensors, MEMS, and related technologies. With over three decades of experience, Radiant delivers precision, reliability, and unmatched customization to meet the unique needs of every customer.



Why Choose Radiant?

✓ **PROVEN EXCELLENCE**

BACKED BY ACADEMIC RESEARCH AND TRUSTED LEADING INSTITUTIONS

✓ **COMPREHENSIVE SYSTEMS**

TAILORED OPTIONS TO FIT YOUR SPECIFIC RESEARCH AND DEVELOPMENT GOALS

✓ **USER-FRIENDLY SOFTWARE**

VISION SOFTWARE SIMPLIFIES COMPLEX TESTING WITH INTUITIVE CONTROLS

✓ **GLOBAL COLLABORATION**

SHARED DATA SEAMLESSLY WITH RESEARCH PARTNERS WORLDWIDE

Radiant's ferroelectric and piezoelectric evaluation systems are used across the globe for the characterization of a wide range of devices, including non-volatile memory devices, human detection sensors, pressure sensors, thermal sensors, and various MEMS devices that utilize piezoelectric responses.

In addition to standard test equipment, Radiant offers a variety of optional modules and custom engineering services to provide tailored solutions for your specific research and development requirements.

VISION SOFTWARE • P.3



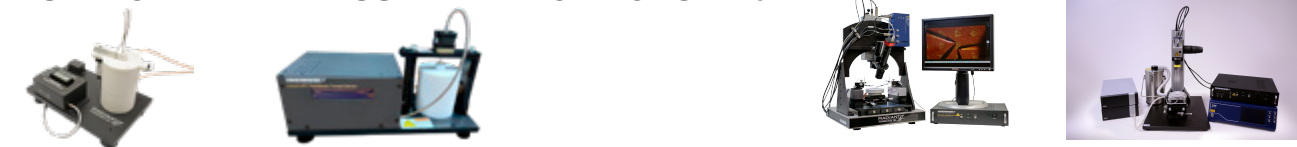
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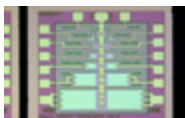
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All Testers Include Vision Software



Vision Software Developed by Radiant Technologies, Inc. is a powerful software platform designed to control external devices such as nonlinear material testers, high-voltage accessories, and displacement sensors. Installed on a Windows-based host computer, Vision communicates through specialized drivers to control external instruments, execute measurements, capture data, and perform advanced analysis—all with an intuitive and integrated interface.

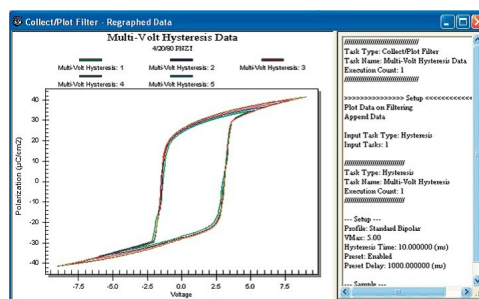
The software comes equipped with two main modes: “QuikLook” mode, which allows for quick and simple measurements while reviewing data one at a time, and “Editor” mode for creating and running more advanced and complex programs. In “Editor” mode, test sequences can be easily assembled through drag-and-drop actions, and features include not only graphing but also automatic axis conversion, data export, and flexible design options for various measurements and data processing.

All data obtained in the Vision environment is collected and saved as archived data along with the measurement conditions. This allows previously executed data to be retrieved at any time. Furthermore, the data and measurement conditions can be shared with research partners via internet or intranet connections, enabling shared evaluation of test procedures and management.

Vision offers high versatility, easily connecting to external devices equipped with GPIB or LAN, enabling seamless execution of complex measurements in collaboration with such devices. It also supports connections and controls for external equipment not manufactured by Radiant, like high-voltage amplifiers or thermal chambers. Combined with the temperature control programs within Vision software, it allows automatic measurement of electrical properties at different temperatures.

Samples of the measurement software included with Vision Software

- Hysteresis
- Remanent Hysteresis
- Time Dependent Component
- DLTS
- PAINT
- Leakage Current
- Fatigue Test
- PUND
- Energy Curve
- Retention
- Imprint
- Magnetoelectric Response
- Ferroelectric Transistor



Vision Software enables automatic execution and plotting of multiple hysteresis loops with a single command

Ferroelectric and Piezo Testers - A Rich Lineup Tailored to The Needs of Research Environments. Radiant offers five types of testers, each designed to meet specific research and production needs. The RT66C, LCII, Premier II, Multiferroic II and PiezoMEMS Analyzer. In addition, Radiant provides accessories that expand testing capabilities to measure transistor, magnetoelectric, thermal, and piezoelectric properties.



PiezoMEMS Analyzer

The newest tester, PiezoMEMS Analyzer supports high-speed, high precision testing for MEMS sensors and actuators. In addition to traditional evaluation of ferroelectric and piezoelectric properties, it can simultaneously assess electromechanical properties essential for the development of MEMS sensors and actuators. This plays a significant role in enhancing efficiency in material development.



Multiferroic II

Precision Multiferroic II Ferroelectric Tester, has a unique frequency rating of 270KHz at +/-100V built-in to the system. The Multiferroic II tester makes testing of thin films and bulk ceramics a fast and simple process. It captures 32,000 points at 2 MHz to achieve exquisite frequency resolution in DLTS or PAINT measurements.



Premier II

Precision Premier II is an advanced tester that has a large test envelope in terms of frequency response, voltage range and accuracy. The Premier II has a fast hysteresis frequency rating of 250KHz at +/-10V built-in to the system. The Precision Premier II tester is capable of executing a single pass hysteresis loop in 100 μ s with no interlacing of the data acquisition.



LC II

The Precision LCII is Radiant's answer to a growing need for affordable characterization equipment. It is an ideal general-purpose tester with a broad test range for thin films and bulk ceramics, with a frequency rating of 5KHz at +/-200V built-in to the system. Using up to 32,000 points with 18-bit resolution from 2kHz out to 1/30th of a Hertz for capacitors ranging from square microns to square centimeters, the LC II enables high resolution characterization for bulk capacitors.



RT66C

The Precision RT66C is perfect for a researcher looking for a flexible unit at an affordable price. The RT66C Test System has a hysteresis frequency rating of 1KHz. The RT66C is offered in a +/- 200V built-in drive volt option. The RT66C can be expanded to 10kV with the addition of a 10kV High Voltage Interface and a High Voltage Amplifier.

****All Testers can be expanded to +/-10kV, with additional accessories*****

Reliable Data

Radiant pioneered and developed the first ferroelectric test system which quickly became the world-wide industry standard for characterizing non-linear materials. Precision and accuracy has been the driving force behind the engineering of our test equipment and thin ferroelectric film components. Radiant designs its testers to minimize distortion and maximize accuracy.

Radiant's test systems are globally acknowledged for their precision and data reliability, establishing the company as the leader in ferroelectric and piezoelectric testing.

Radiant's testers also accommodate a broad spectrum of measurement needs, making them ideal for use in academic research as well as industrial settings. The intuitive user interface streamlines experiment setup, allowing users to quickly adjust parameters and monitor results in real time. With robust safety mechanisms and comprehensive documentation, Radiant ensures both reliable performance and user confidence throughout the measurement process.

Key Features

- Fatigue measurement by using external signals.
- Built-in Power supply for MEMS Testing: $\pm 10V$, $\pm 30V$, $\pm 100V$, $\pm 200V$, $\pm 500V$
- User controllable function for Continuously Variable Pulse Widths and Hysteresis Measurement Times
- Continuously Variable Pulse Widths and Hysteresis Measurement Times
- Connectable to a 10kV High Voltage Interface (HVI) with protection features
- Virtual Ground Measurement Circuit
- Various Components for Internal Auto-Calibration and High-Performance Precision Ports
- External sensor port supports devices like displacement meters and temperature sensors.
- Automatic measurement with a 48-channel multiplexer; high-voltage multiplexer (optional)
- Vision Data Management Software Enabling Researchers to Customize Tests
- Vision Software Compatible with Windows 10 and 11 (64-bit)
- Data Formats that Allow Global Sharing of Measurement Conditions and Data Among Researchers
- LAN Standards: Communication via 10/100/1000BASE-T or GPIB (Dependent on Host PC)
- Ability to compare stored data with freshly measured data.
- Automatic power supply selection from 100V to 220V

Ferroelectric Testers and PiezoMEMS Analyzer

Tester Parameter	PiezoMEMS Analyzer	Multiferroic II	Premier II	LC II	RT66C
Voltage Range (built-in drive voltage)	±100V, ±200V	±100V, ±200V, ±500V	±10V, ±30V, ±100V, ±200V, ±500V		±200V
Voltage Range with an External Amplifier and High Voltage Interface (HVI)	10kV				
Number of ADC Bits	18				14
Minimum Charge Resolution	0.80fC			<10fC	122fC
Minimum Area Resolution <i>(assuming 1ADC bit = 1μC/cm²)</i>	0.08μ ²			<1μ ²	12.2μ ²
Maximum Charge Resolution	5.26mC			276μC	4.8μC
Maximum Area Resolution <i>(assuming saturation polarization = 100μC/cm²)</i>	52.6cm ²			2.76cm ²	4.8mm ²
Maximum Charge Resolution with High Voltage Interface (HVI)	526mC			27.6mC	480μC
Maximum Area Resolution <i>(assuming saturation polarization = 100μC/cm²) w/o HVI</i>	>100cm ²				4.8cm ²
Maximum Hysteresis Frequency	270kHz @ 10V 270kHz @ 100V 100kHz @ 200V	270kHz @ 10V 270kHz @ 100V 100kHz @ 200V 5kHz @ 500V	250kHz @ 10V 50kHz @ 30V 50kHz @ 100V 50kHz @ 200V 2kHz @ 500V	5kHz @ 9.9V 5kHz @ 30V 5kHz @ 100V 5kHz @ 200V 2kHz @ 500V	1kHz
Minimum Hysteresis Frequency	0.03Hz				1/8th Hz
Minimum Pulse Width	0.5μs			50μs	500μs
Minimum Pulse Rise Time (5V)	400ns			40μs	500μs
Maximum Pulse Width	1sec				100ms
Maximum Delay between Pulses	40ks				
Internal Clock	25ns				50μs
Minimum Leakage Current <i>(assuming max current integration period = 1 seconds)</i>	2pA			12pA	10pA
Maximum Small Signal Cap Frequency	1MHz			20kHz	2kHz
Minimum Small Signal Cap Frequency	1Hz				10Hz
Output Rise Time Control	10 ⁵ scaling			10 ³ scaling	2 settings
Input Capacitance	~6fF	~6fF	~6fF	~6fF	1pF
Electrometer Input All Test Frequencies for all test at any speed	Yes				
LCR	Internal	-			
Multiplexer	Internal	Option			
I2C DAC	Internal	Option			

**Specifications are subject to change without notice.*

High Voltage Application Option

By connecting high-voltage options to Radiant's ferroelectric and piezoelectric testers, material evaluation under high voltage becomes possible. The setup includes a high-voltage amplifier (HVA) that generates high voltage, a high-voltage interface (HVI) with four protection functions to safeguard the tester from damage caused by sample failure, malfunctions of HVA itself, and a high-voltage test fixture (HVTF) that protects the operator from the risk of electric shock. Even if abnormal discharge occurs during measurement, the design ensures the safety of the operator during and after the test. It's robust design delivers exceptional safety and reliability, maintaining full protection at voltages up to $\pm 10\text{kV}$.

High Voltage Interface (HVI)



The HVI ensures the correct application of high voltage from the high-voltage amplifier to the sample. Additionally, it protects the ferroelectric tester from overloads caused by sample failure during high-voltage application. Furthermore, it releases residual charges from the sample after the test, protecting the operator from the risk of electric shock during sample retrieval.

Technical Specifications

Maximum Amplifier Voltage	Mains Electricity	High-Speed Protection Current Value	High-Speed Trigger Voltage Value
$\pm 10\text{kV}$	100V ~ 240V 50 ~ 60Hz (Auto Select)	10A	2.1V

Low-Speed Protection Delay Time	Isolation Relay Switch Voltage	Internal withstand Voltage	Panel, Mount, Connector Pressure Resistance Value
~ 14ms	12kV	>40kV DC	20kV

High Voltage Amplifier 10kV



The 10kV amplifier extends measurement capability by amplifying the standard voltage signal ($\pm 10\text{V}$) from ferroelectric and piezoelectric testers to a maximum of $\pm 10\text{kV}$ and applies high voltage to the sample. We offer a variety of models to meet customer needs, including options for $\pm 500\text{V}$, $\pm 2000\text{V}$, $\pm 4000\text{V}$, and $10,000\text{V}$. We also propose optimal high-voltage amplifiers tailored to measurement purposes and conditions, such as high-speed response types for MEMS.

High Voltage Sample Holder

HVTF - High Voltage Test Fixture



Manufactured from Teflon with excellent insulating properties, this test fixture supports voltage applications of up to 10kV . The sample is held between copper electrodes inside a chamber and is electrically connected to external terminals. By filling the chamber with insulating oil, the sample is protected against arcing phenomena common in atmospheric conditions, while the system accommodates environments of up to 230°C .

Cryogenic High Voltage Probe (P450)



This high-voltage probe is designed for ultra-low temperature applications and is fully compatible with Quantum Design's PPMS[®] and DynaCool[™] systems. The maximum permissible voltage is determined by variables including the geometry of the sample and the prevailing vacuum conditions. It is optimized for Radiant's high-voltage applications, providing dependable performance in harsh conditions.

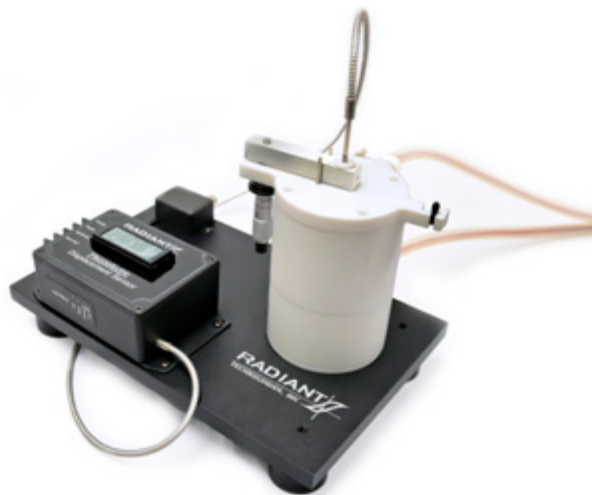
Displacement Measurement Option

d33 Bulk Piezoelectric Response Measurement System



AutoCal230C Piezoelectric Thermal Chamber - Converse d33

Auto Cal 230°C (Converse D33) Piezoelectric Thermal Chamber measures bulk piezoelectric constants (converse d33) with precision in heated environments up to 230°C. The Auto Cal 230C consists of an optical displacement sensor, a high-voltage displacement measurement fixture with a heating mechanism, and advanced piezo software. The optical displacement sensor detects the displacement of bulk samples (100nm or more) and determines the piezoelectric constant d33 in a heated environment (up to 230°C). It supports the application of high voltage up to 10kV to the sample. The test Bundle includes a Piezoelectric Displacement Sensor, High Voltage Displacement Measurement Test Fixture and Advanced Piezoelectric Software.

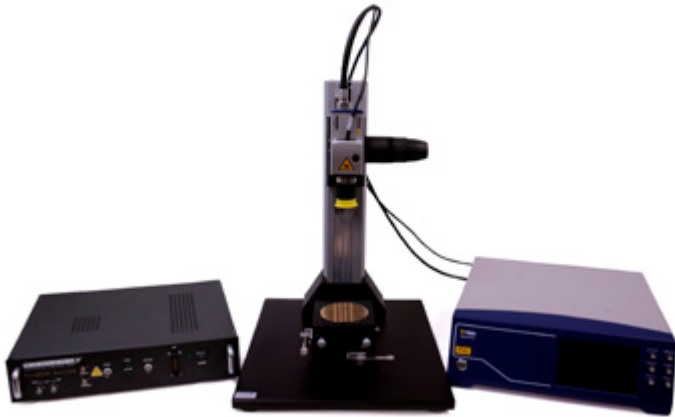


Non-heated Bulk Piezoelectric Test Bundle – Converse d33 (B-PTB)

The Non-Heated Piezoelectric Test Bundle - Converse d33 (B-PTB) offers all of the features of the AutoCal230, except of the integrated heating element and measures at room temperature only. The fixture is rated to 10kV.

Thin Film Piezoelectric Response Measurement Systems

High Resolution Angstrom-Level Measurement Platform and Nano Measurement Platform



High Resolution Angstrom-Level Measurement Platform

High Resolution Angstrom-Level Measurement Platform - A Laser Vibrometer integrated with a Radiant Precision Test System precisely measures the piezoelectric coefficient (d_{33}) of piezoMEMS and bulk devices as well as the surface motion of clamped thin films. Measures 2-20 μm spot size, 3 MHz Bandwidth, Integrated camera, and 0.65nm loops. Includes Radiant's Advanced Piezoelectric Software which allows fully automatic control of the High-Resolution Angstrom-Level Measurement Platform and a Simple Test Station to easily and reliably contact samples. A Thermal Stage can be added to the Thin Film Piezoelectric Test Bundle to measure -195°C to 600°C in a single test profile.

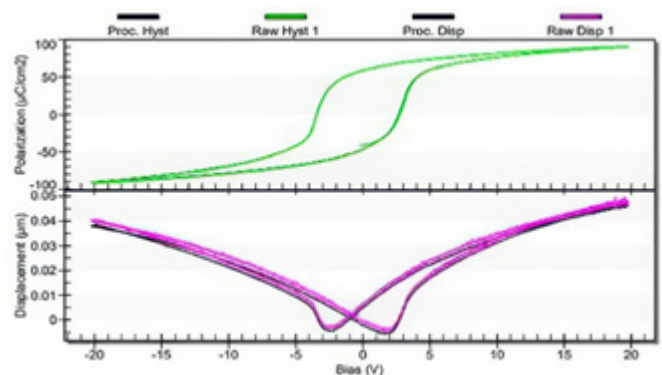
Nanometer Measurement Platform



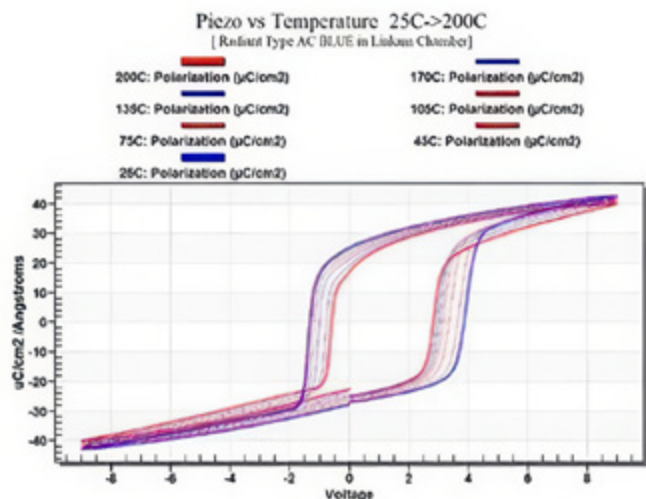
Nanometer Measurement Platform

Nanometer Measurement Platform - A Radiant Precision Test System combined with a Nanometer Laser allows accurate measurement of the piezoelectric (d_{33}) coefficient on packaged parts. Measures 65 μm spot size and 2nm loops. The cost-effective laser is mounted horizontally to be used with Radiant's Simple Test Station, Bulk Ceramic Test Fixture and/or a Thermal Stage (-196°C - 650°C). An auxiliary USB camera is included in the system to allow precise focus onto the target of interest.

Hysteresis and Butterfly Curve



Displacement Response Measurement in a Temperature-Controlled Environment



Bulk Piezoelectric Test Bundle – Converse d33 (B-PTB)

Through collaboration with Linkam Thermal Stages, Radiant has developed and launched a new environmental test stage capable of applying voltages up to $\pm 300\text{V}$ in environments ranging from -196°C to 600°C . The unit includes four microprobes connected to BNC terminals, operating within this wide temperature range. The maximum sample size is 20mm in diameter.

The temperature control stage offers two heating rates: $150^\circ\text{C}/\text{min}$ and $2.5^\circ\text{C}/\text{min}$. This high heating rate, combined with Radiant's microprober, allows for the determination of the pyroelectric coefficient of samples. The environmental test unit features a 12.5mm viewing window, enabling simultaneous measurement of hysteresis curves and sample displacement responses when used with a laser displacement meter.

When combined with Radiant's fully automated measurement system, users can design experiments to automatically vary temperature and applied voltage while measuring hysteresis curves and sample displacement responses and generate various graphs.



Radiant Tester, LDV,
Thermal Stage

Dual e31 Piezoelectric Cantilever System

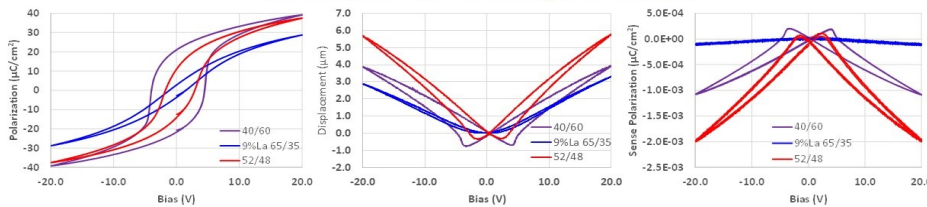


Direct and Converse e31 Measurement (Dual e31)

Radiant's revolutionary approach to measuring both direct and converse e31 coefficients simultaneously using a single sample and test fixture. This technique reduces the need for multiple samples and fixtures, significantly improving efficiency and accuracy in piezoelectric characterization.

- Engineered using our Converse e31 measurement system as a foundation.
- Single/Dual 2" or 4" Cantilevers
- Photonic displacement sensor self-calibrates
- Five BNC connections
 - » Four pogo pins on cantilever frontside
 - » Fifth for cantilever backside to ground substrate
 - » Vision controlled connection
- Lid (not shown) reduces thermal and electrical noise

Results vs Composition



PZT	e_{31} (C/m ²)		R ² Fit
	Converse	Direct	
4%Nb 20/80	-12.3	-7.7	0.9992
30/70	-13.4	-10.5	0.9989
40/60	-9.8	-9.5	0.9995
52/48	-14.4	-11.9	0.9975
65/35	-9.8	-3.8	0.9970
9%La 65/35	-8.2	-1.4	0.8829

- Converse follows displacement trend
- Direct follows sense polarization trend

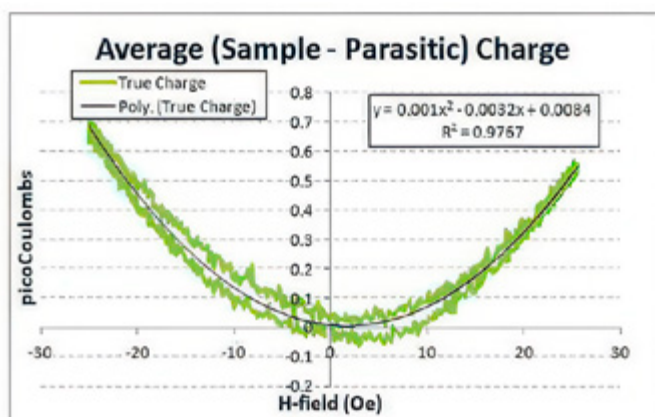
Magnetoelectric Response Measurement System



Multiferroic materials, which possess both ferroelectricity and ferromagnetism, exhibit magnetoelectric effects where electric fields induce magnetism (or vice versa). This makes them promising materials for next-generation electric/magnetic devices. Radiant's magnetoelectric response measurement system measures the small charges generated by applying a magnetic field to bulk and thin film samples.

The magnetoelectric response program measures the charge generated in multiferroic capacitors or magnetoelectric composite devices induced by a magnetic field. This program can also be used in combination with various coils and magnetic field sensors.

The figure on the left shows the measurement results using the magnetoelectric (ME) response program for a sample with a magnet attached to a PNZT thin film. The actual response charge was within 15% of the theoretical value calculated from the piezoelectric constant of the PNZT capacitor and the calculated strength of the magnetic field coil.



Devices like magnetoelectric MEMS, which use ferroelectric thin films, show marked sensitivity when exposed to higher magnetic field strengths. In contrast, bulk ceramic ME devices yield only a small charge level at amplitudes around ± 50 Oersted. To perform ME measurements at larger magnetic field amplitudes, replacing a Helmholtz coil with a field coil offers a simple solution. Of course, such a field coil requires an exceptionally large current source for its operation. For inquiries regarding these magnetic field coils, please contact our equipment representative.

Ferroelectric Wafer Sales

Radiant Technologies, Inc. sells various Si wafers coated with ferroelectric thin films such as PZT, PLZT, and PNZT, as well as Pt bottom electrodes. With experience and a long history in film deposition, they also perform a series of tasks including electrode and ferroelectric film deposition and dicing. Radiant can fabricate ferroelectric thin films, top electrodes, or bottom electrodes not listed in the table, and they can also deposit ferroelectric materials like PZT on bottom electrodes fabricated by customers.

Sample List of Pt Bottom Electrode Ferro-Electric Thin-Film Four-Inch Wafer

FOUR-INCH SILICON WAFERS			
Composition	Electrode	Pattern	Minimum Purchase Quantity
Pt	Bottom Electrode	None	5 Pieces
4/52/48 PLZT	None	None	1 Piece
	Top and Bottom Electrode	None	
	Top and Bottom Electrode	Gold patterned, PZT Patterned	
4/20/80 PNZT	None	None	
	Top and Bottom Electrode	None	
	Top and Bottom Electrode	Gold patterned, PZT Patterned	
0/20/80 PZT	None	None	
	Top and Bottom Electrode	None	
	Top and Bottom Electrode	Gold patterned, PZT Patterned	
9/65/35 PLZT	None	None	
	Top and Bottom Electrode	None	
	Top and Bottom Electrode	Gold patterned, PZT Patterned	
15/0/100 PLZT	None	None	
	Top and Bottom Electrode	None	
	Top and Bottom Electrode	Gold patterned, PZT Patterned	

**Delivery schedule and pricing depend on the ferroelectric components, electrode combinations, and configuration details.*

Manufacturing and Sales of Ferroelectric & Piezoelectric MEMS Devices

Radiant Technologies, Inc. leverages years of expertise in the fabrication of ferroelectric thin films to produce ferroelectric and piezoelectric MEMS devices. Radiant supports the creation of unique devices using ferroelectric and piezoelectric materials. They also have experience in fabricating devices using pattern masks for top and bottom electrodes and protective films. If you have any questions, please feel free to contact us.

Inquiries: www.FerroDevices.com