



# EMXmicro & EMXplus

- Supreme Resolution and Sensitivity for EPR Spectroscopy

# Discover the World of EPR

## Fields of Application

### Chemistry

- Kinetics
- Redox chemistry
- Free radical mechanisms
- Reaction intermediates
- Catalysis
- Electrochemistry

### Life Sciences

- Structural biology
- Aging
- Cell damage and death
- Oxidative stress and inflammation
- Proteins and enzymes
- DNA and RNA
- ROS and RNS
- Spin labeling
- Spin trapping

### Material Research

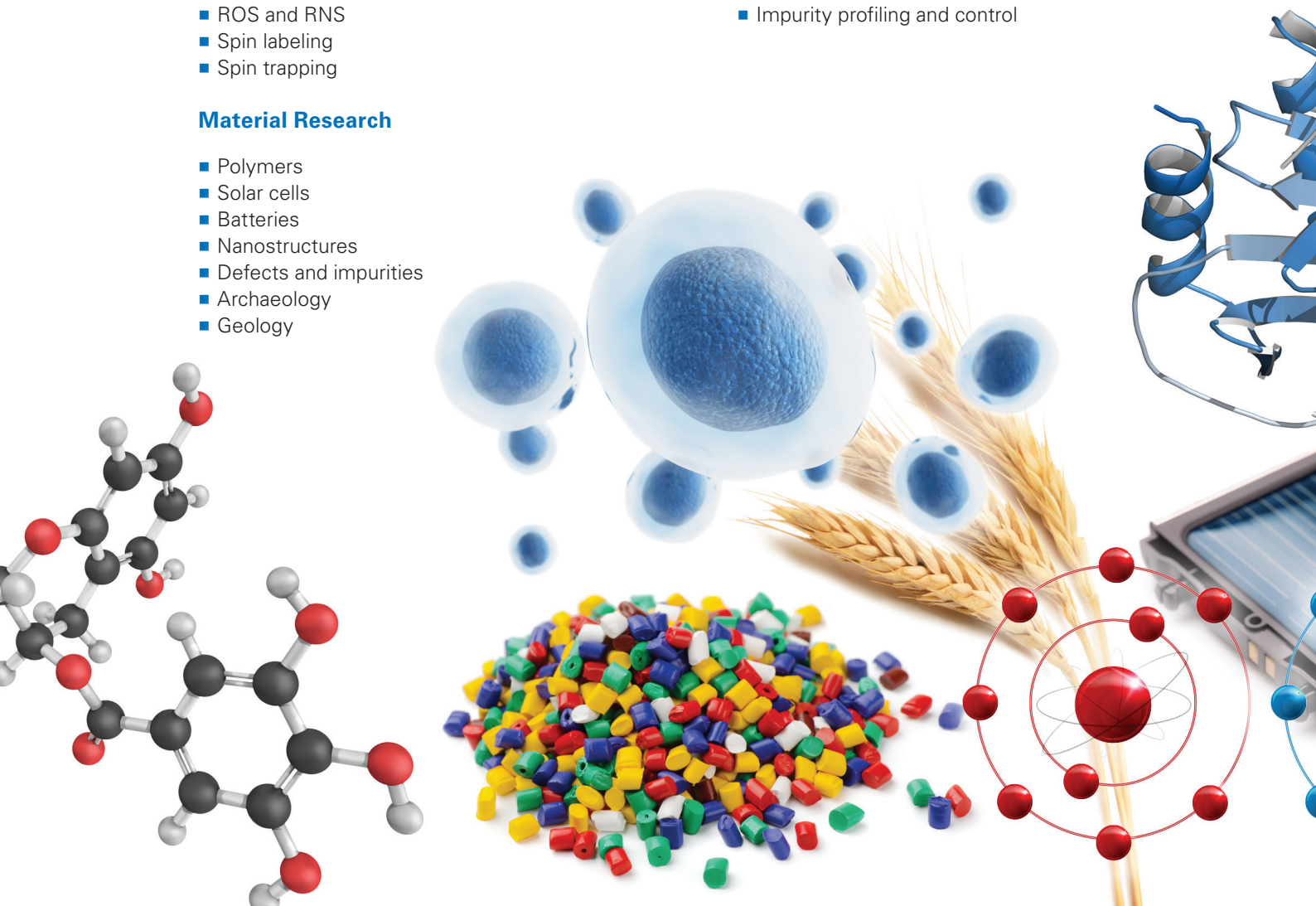
- Polymers
- Solar cells
- Batteries
- Nanostructures
- Defects and impurities
- Archaeology
- Geology

### Physics

- Semi conductors
- Magnetic properties
- Superconductivity
- Quantum computing

### Industrial Research

- Pharmaceuticals
- Environmental
- Agricultural
- Food and beverages
- Health and personal care
- Product stability and shelf-life
- Forced degradation
- Antioxidant capacity
- Impurity profiling and control

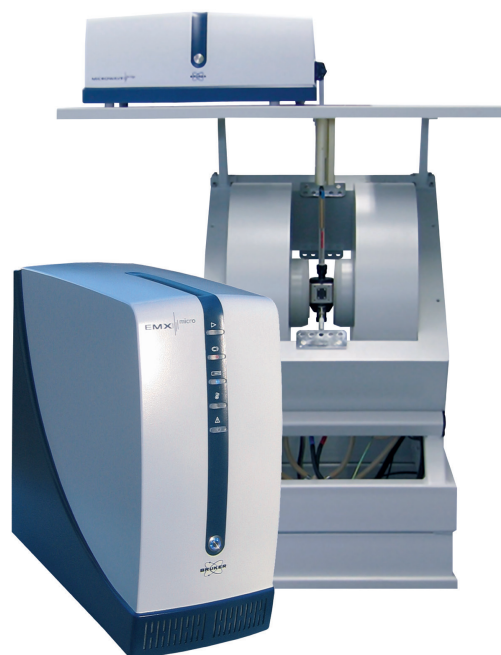
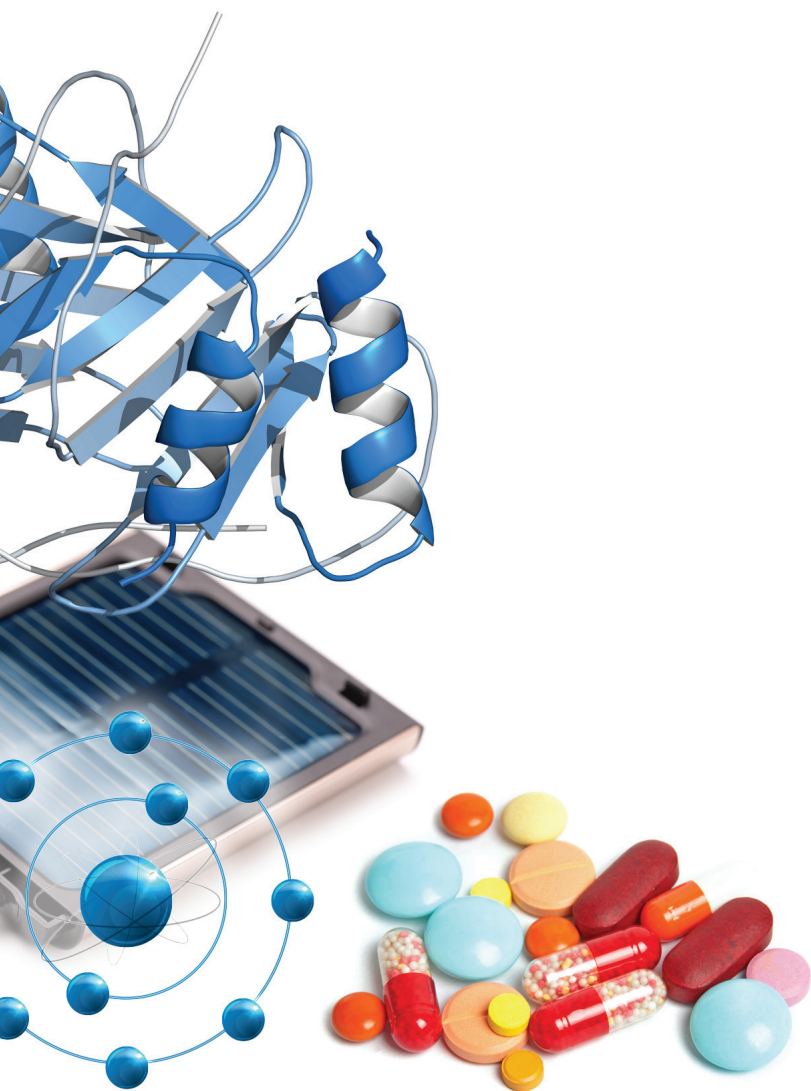


## ● Research Performance at Your Finger Tips

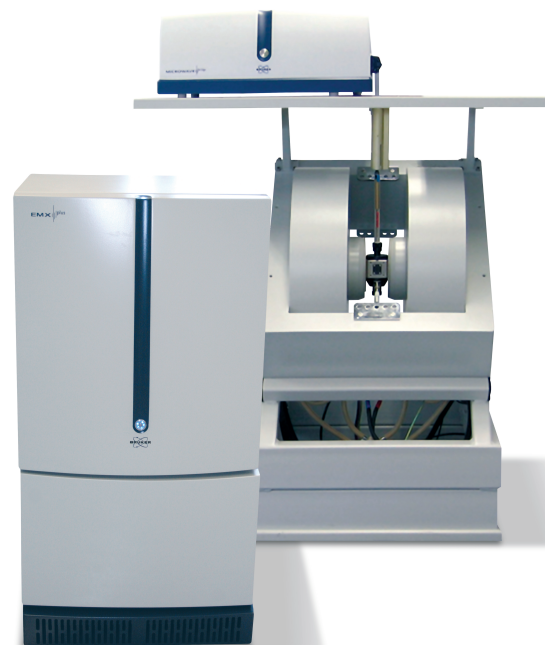
With the EMXmicro and EMXplus, the EMX spectrometer line has continually evolved to meet new demands for ever better performance.

### The EMXmicro and EMXplus feature the latest hardware and software solutions to provide:

- High sensitivity
- High resolution
- Full calibration for quantification
- Spectral simulation and fitting
- Versatile and expandable configurations for experimental needs
- Full range of accessories and options
- On-site and remote service and support
- Decades of experience in EPR instrumentation
- World-wide application centers with EPR experts



Compact foot print with EMXmicro

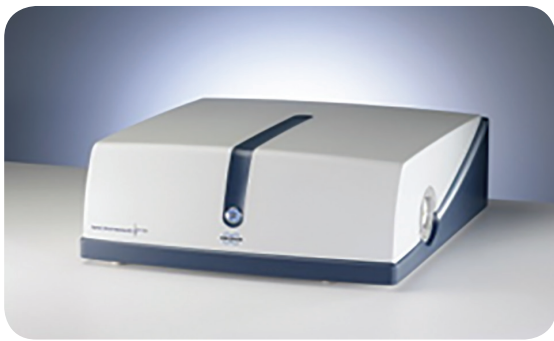


Extended functionality with EMXplus ENDOR and Teslameter

# Supreme Sensitivity and Resolution

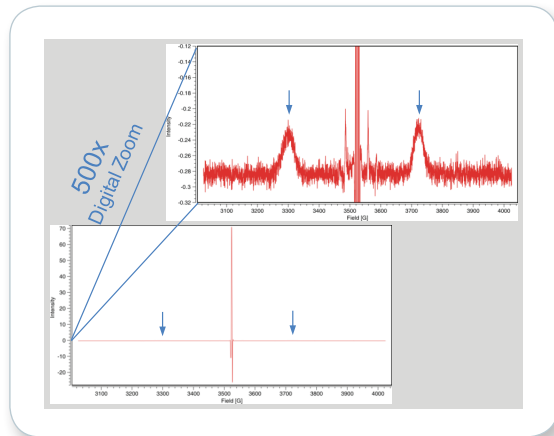
## PremiumX Microwave Bridge and High Sensitivity Resonator, the Perfect Match for Optimum Sensitivity

- Weak Pitch signal-to-noise of 2000:1
- Absolute sensitivity  $1.6 \times 10^9$  spins/G

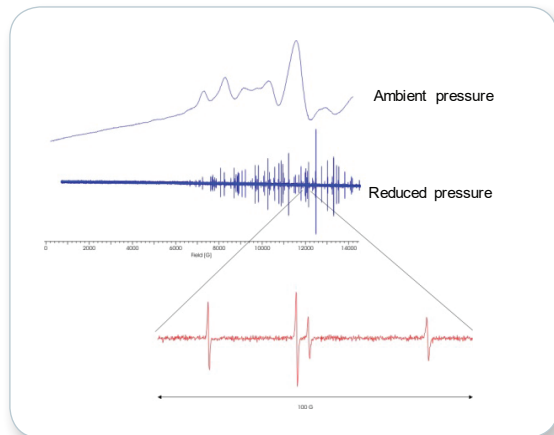


## High Dynamic Range for Ease of Use and High Precision

- Amplitude resolution of 50 ppb with Signal Channel
- Sweep resolution for field of 256 000 points with Field Controller



High amplitude resolution EPR spectrum of irradiated quartz. Digital zooming reveals the otherwise invisible peaks of the trapped hydrogen atoms.



High resolution, molecular oxygen Q-band EPR spectrum. Zoomed area shows resolved individual EPR lines of the low pressure spectrum. Single 14 kG Sweep with 80 mG Resolution

## ● The Xenon Software Suite

Xenon is a full suite for EPR data acquisition, processing, and analysis. Xenon guides the user from beginning of acquisition through analysis with various targeted workflows.

### Acquisition:

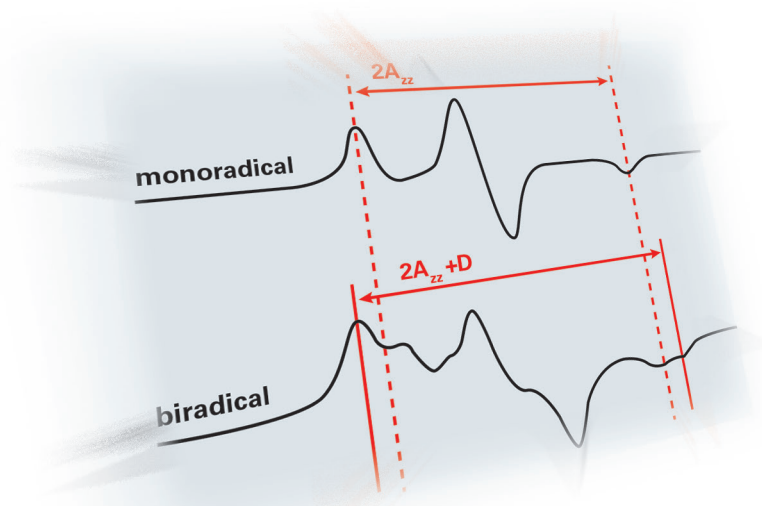
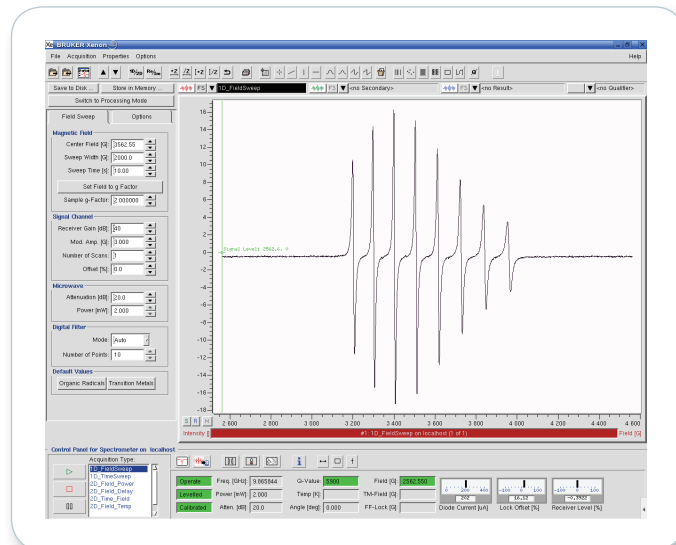
- Fully calibrated system for quantification
- Automatic sweep resolution
- Automatic accessory recognition

### Processing routines cover all aspects of EPR:

- Baseline correction
- g-factor reading
- Distance reading
- Peak-picking
- Double integration
- Digital filtering
- ...

### Data analysis routines

- SpinCount
- SpinFit
- Spin trap library
- $P_{1/2}$  Analysis



# Quantitative EPR Package

Quantification and identification, the most demanded but challenging analyses in EPR, have become easy tasks with Bruker's SpinCount and SpinFit.

## SpinCount for Quantitative EPR

- Single measurement
- No reference sample required
- No need for calibration
- Works with all sample types
- Works at all temperatures

## SpinFit for Identification

- Spectrum simulation and fitting for isotropic and anisotropic signals
- Extensive spin-trap library for quick identification
- Library for common EPR solid species
- Integrated SpinCount quantification

The screenshot displays the Bruker EPR software interface with several windows open. The 'NUMBER OF SPINS' dialog box is in the foreground, with the 'Double Integration' button highlighted. To its right is a plot of Intensity [I] versus Field [G], showing a derivative EPR signal with a peak at 3527.27584 G. Below this is the 'Absolute Spins Report' window, which contains the following data:

REPORT	xmin	xmax	spins/nm <sup>3</sup>	N	spins
END_REPORT	3.475e+03	3.563e+03	7.121e+13	1.182e-04	5.555e+13

The 'Spin Fitting' window is also open, showing a table of radicals and their parameters:

Radical	Name	Rad	Rad0	g Factor	Line Width	Line Shape	Area
	Rad4		Rad0	2.00524	1.07907	0.794172	20.5
				2.00511	1.01373	0.657838	17.06

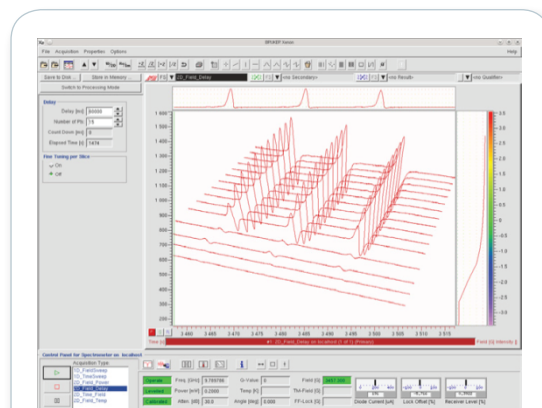
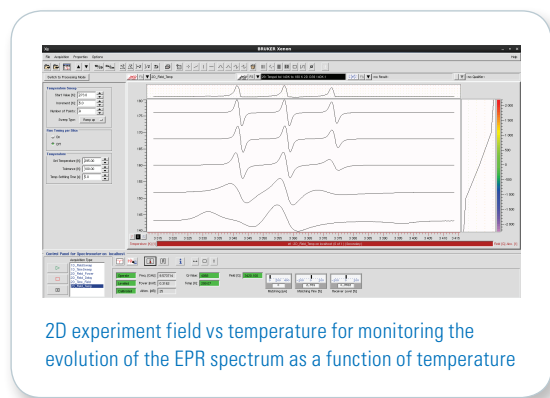
The 'Spin Fitting' window also includes a 'Spin Count...' button. To the right of the 'Spin Fitting' window is the 'Spin Fit Report' window, which displays a plot of the experimental EPR signal (Experiment) and its fit (Fit) for three different species: DMPHO-hydroxyethyl (C = 6 µM), DMPHO-hydroxyethyl (C = 6 µM), and DMPHO-hydroxyl (C = 2 µM). The plot shows the derivative EPR signal versus Field [G] from 3420 to 3560 G. The 'Area' value for the fit is 2.050e+01.

## ● Advanced Acquisition Modes

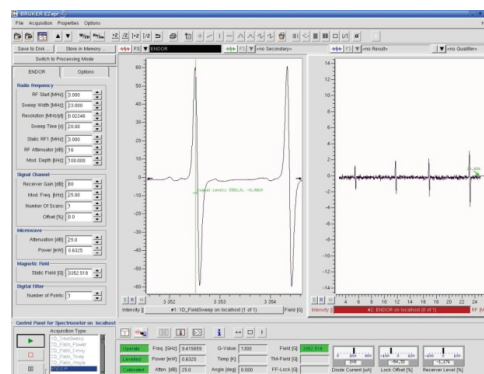
Predefined experiment set-ups for user guided 1D and 2D acquisitions

### Acquisition modes:

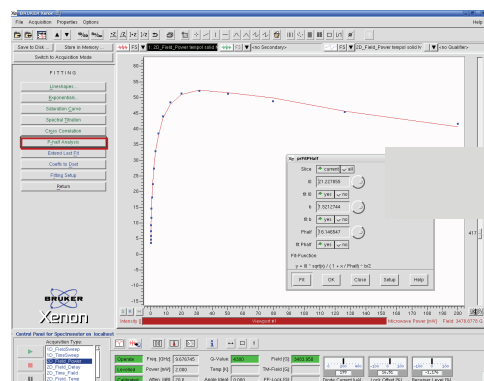
- Field Sweep
- Time Sweep
- Field vs Time
- Field vs Power
- Field vs Temperature
- Field vs Sample Angle
- ENDOR



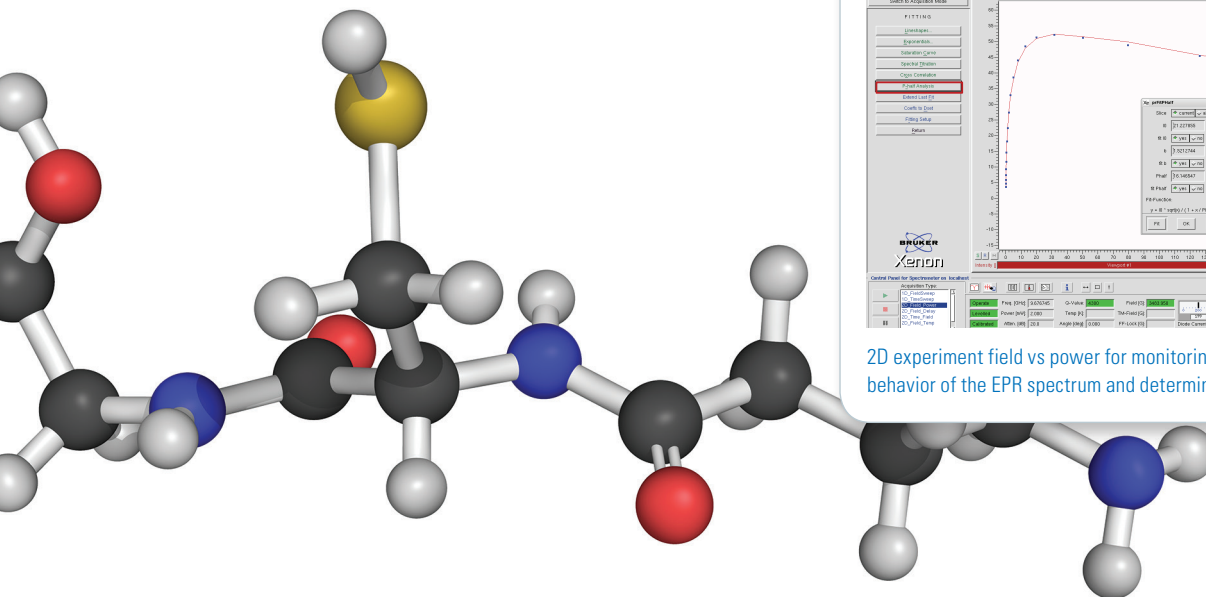
2D experiment field vs temperature for monitoring the evolution of the EPR spectrum as a function of temperature



Split screen display for convenient selection of field positions for ENDOR spectrum acquisition



2D experiment field vs power for monitoring the saturation behavior of the EPR spectrum and determining the  $P_{1/2}$  value



# Temperatures from 3.8 K to 1200 K



## **In-Cavity & FlexLine liquid Helium based Variable Temperature systems (ER 4112HV and ER 4112HV-F)**

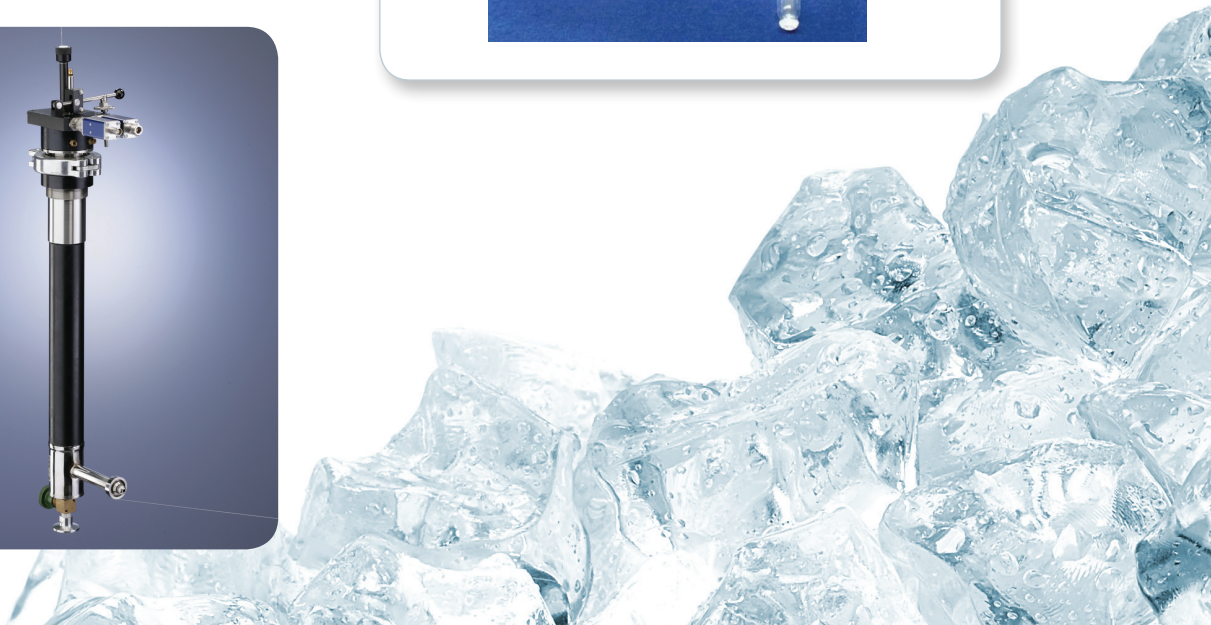
The accessible temperature range is 3.8 K to 300 K. Sample exchange at any temperature is a standard feature. Optical windows for sample irradiation. Compatible with all magnet systems.

## **In-Cavity & FlexLine Nitrogen based Variable Temperature systems (ER 4131VT and ER 4131VT-F)**

The system makes use of liquid or gaseous Nitrogen. The accessible temperature range is 100 K to 1200 K. Optical windows for sample irradiation. Compatible with all magnet systems.



For all VT systems the digital control unit monitors and controls the temperature measured with a sensor close to sample's position. It is fully remote controllable via the acquisition software.



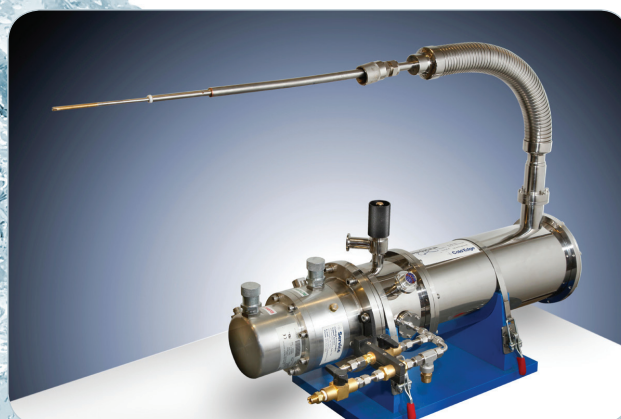


## ● Variable Temperature Accessories - Essential Tools for EPR

### Cryogen-Free In-Cavity & FlexLine Variable Temperature Systems

Sources of liquid helium have become limited, expensive and delivery unreliable. These systems free the spectroscopist from the need to purchase liquid cryogens to attain the low temperatures required for many EPR experiments.

- Temperature down to 5 K
- Optical access
- Rapid sample exchange
- Compatible with the 9.5" and 10" magnet systems



# Full Range of Accessories

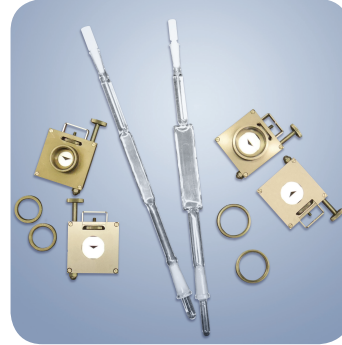
Boost your system with various accessories, dedicated for your experimental needs

## Sample handling and treatment

- Sample containers
  - Tubes, various diameters
  - Flat cells
  - Tissue cell
  - AquaX
  - TPX tubes
  - Electrolytic cell
  - Mixing cell
  - UV irradiation system

## Special purpose accessories

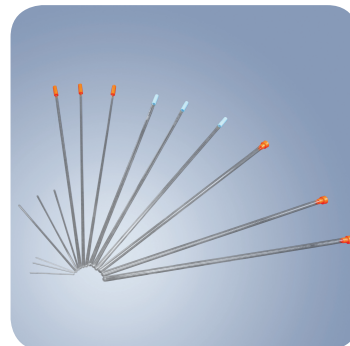
- Goniometer
- Teslameter
- ENDOR



Aqueous solution cells and holders



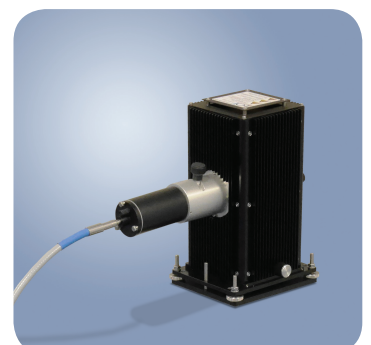
Programmable Goniometer



Sample tubes various sizes



AquaX multicapillary sample cell



UV lamp (Hg/Xe)

## ● Wide Range of X-band Resonators

Boost your system with resonators dedicated for specific applications and samples



Dielectric resonator for very small (3mL) sample volumes



Mixing Resonator for reaction kinetics



High Temperature resonator up to 1200 K



ENDOR resonator



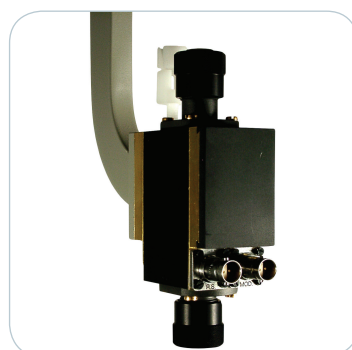
Dual Mode resonator for detection of forbidden transitions for  $S > 1/2$



TM mode resonator for large aqueous volumes



Optical transmission resonator



Standard resonator for high time resolution



# Multifrequency EPR

Simplifying EPR spectra with multifrequency accessories for L-, S-, X-, and Q-band.

## The multifrequency advantages:

- Increase sensitivity with frequency
- Increase resolution
- Disentangle field dependent and independent interactions
- Unravel overlapping EPR species
- Selective time windows for molecular motions



Q-band microwave bridge



Q-band resonators for EPR, ENDOR, and optical excitation

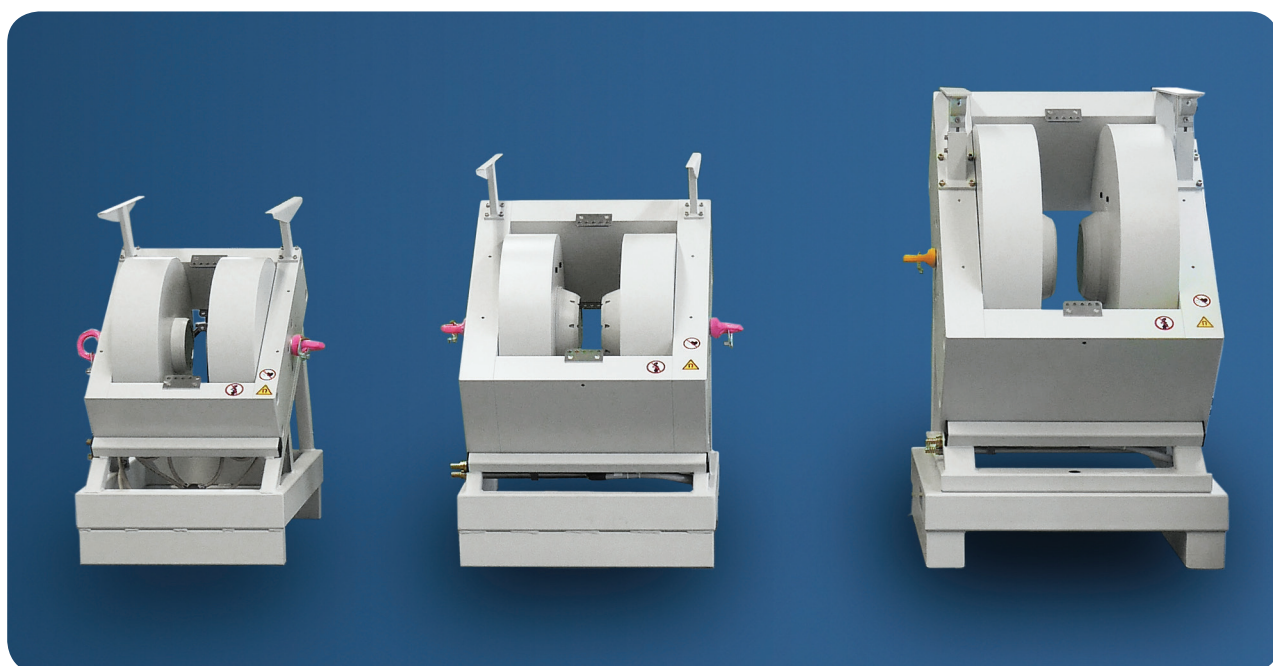


L-band 23 mm resonator for large objects

## ● Magnet Systems

Tailor your EMX spectrometer with the magnet that matches your applications and infrastructure.

Magnet / Power Supply	Max. Field Strength (kG)	Air Gap (mm)	Weight (kg)
6" / 1 kW	6	60	500
9.5" / 2.7 kW	9	62	900
9.5" / 12 kW	13	62	900
10" / 2.7 kW	10	72	1700
10" / 12 kW	14	72	1700
with pole-tips	17	56	1700
10" W / 2.7 kW	7	100	1750
10" W / 12 kW	11	100	1750



# Specifications

	EMXmicro	EMXplus
X-band Sensitivity	1.6 x 10 <sup>9</sup>	
Q-band Sensitivity	1 x 10 <sup>9</sup>	
Modulation frequency	10 and 100 kHz	From 4 to 100 kHz in 1 kHz steps
Modulation amplitude	Up to 10 G	Up to 20 G
Field stability	10 mG / hour	10 mG / hour
Sweep Resolution	128 000	256 000
Amplitude Resolution	18 bit	24 bit

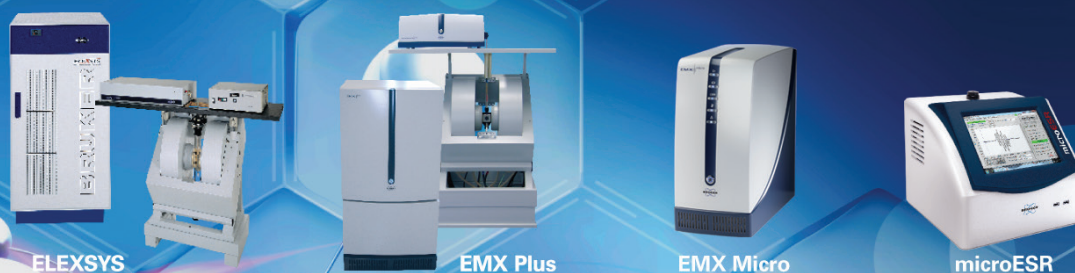


## ● Bruker EPR Portfolio in Full

### Why Bruker EPR?

With more than 50 years of experience, Bruker has built a rapport with the scientific community by understanding and meeting the needs of our users. With more than 90 locations around the globe, we are the world's leading supplier of EPR spectrometers.

Our EPR product family ranges from a sophisticated, compact bench-top model to complex floor-standing systems, serving the widest range of customer needs.



#### Helping You with Your Experiments

- Assisting you with design, acquisition and analysis
- Full coverage of CW and Pulse EPR techniques
- Application, software, and hardware support/development

#### Comprehensive Application Network

- Global assistance from 9 Dedicated Application Scientists
- Expertise in Biochemistry, Chemistry, and Physics
- CW/Pulse EPR Centers in China, Europe, Japan, and USA

#### Long-term Relationships

- From the very beginning, we provide the support you want
- Over 40 years dedicated to the EPR community
- Extended collaborations with the EPR community

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# EPR: Seeing the Unseen

EPR (Electron Paramagnetic Resonance) spectroscopy is the only technique that unambiguously detects and quantifies species with unpaired electrons. These include free radicals, many transition metals, and defects in materials.

Free radicals and transition metals play crucial roles in many processes such as photosynthesis, oxidation/reduction, catalysis, and polymerization reactions. As a result EPR crosses many disciplines such as medical science, biology, chemistry, physics, material science, archeology and forensics.

Most free radicals have damaging effects on their surroundings. Free radicals are involved in cancer, aging, Alzheimer's, and cardiovascular diseases. Degradation of material properties such as brittleness and discoloration of polymers is frequently caused by free radical reactions.

## Versatile and Nondestructive

EPR can be used to detect unpaired electrons in solids, liquids, gases, colored and turbid solutions, cell suspensions, and in vivo.

The EPR data can be acquired in a matter of seconds and the analysis of the data provides the amount and identity of the species present.