

MATERIAL PROPERTIES, MEASURING METHODS, APPLICATIONS

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The conference addresses all problems relevant to both physical concepts and technological aspects of practical implementation of electromagnetic measurement techniques for determining the electromagnetic properties of materials, and the amount of water in moist substances designated as Microwave Aquametry. The spectrum of subjects and projects is very wide. In order to make it easier for the reader the abstracts of oral contributions and posters are arranged in the following way:

- 1 DIELECTRIC PROPERTIES OF AQUEOUS MATERIALS
- 2 WATER IN MODEL SYSTEMS AND MIXTURE THEORY

Subject <i>Comments</i>	Paper Page	Method Frequency range	Experiments - Results
Water & aqueous solutions; solute/solvent polarisation	S 1.1 3	- 40 GHz	Aqueous systems - characteristic differences to water spectrum
Dipole orientation in Alcohol-water mixtures	P2 420	TDR	Parallel or antiparallel orientation of dipoles in alcohol-water mixtures
Polymer-water interactions in hydrogels / <i>Molecular mobility in hydrogels</i>	S1.2 8	DRS 10^{-2} - 10^6 Hz	Homogeneous copolymers: molecular mobility depends on water content & composition of dry hydrogel
Mesoscopic water droplets in hydrophobic confinement <i>Water droplets in butyl rubber</i>	S1.3 16	5 Hz – 10 GHz 313 K – 213 K	Liquid phase: molecular reorientation equals bulk water; ice phase: orientation activation energy is reduced by defects
Determination of dielectric constants (ϵ_r) of liquids <i>Liquid is treated as extra layer in an U-shaped container</i>	S1.4 25	75 – 110 GHz	Dependent on ϵ of each layer a different transmission factor is obtained; determination of ϵ_r by inverse computation
Influence of humidity on the electrical properties of p-DADMAC-films	P1 415	20 Hz – 1 MHz	Electrical properties will be influenced by humidity; important results for fast humidity sensors.
Surface water in hydrated crystalline saccharides <i>Glucose; mannitol; sorbitol</i>	S2.1 31	IGC, XPS, DRS .615; 1.4; 2.2 GHz	Polarisability of water: glucose>mannitol>sorbitol; properties of water in hydrated material governed by the acid/base characteristics
Dielectric relaxation of water confined in porous glasses	S2.2 39	DRS 20 Hz - 1MHz -100°C - &300°C	The hindered dynamics of water molecules in pores reflects the geometrical structure of porous matrix
Dielectric characterisation of zeolite solutions <i>for microwave processing</i>	P3 423	50 MHz - 20 GHz	Thermal behaviour during heating; Zeolites: VPI5; ZSM%; NaA; NaX Results important for applicator design

Subject <i>Comments</i>	Paper Page	Method Frequency range	Experiments - Results
Thermal & geometrical effects on bulk permittivity of porous mixtures	S2.3 46	TDR 0,2 - 1 GHz 270 - 330 K	Particle shape & bound water effects on permittivity predictions are accounted for by a three-phase dielectric mixture model
Modeling Maxwell-Wagner and diffuse double layer polarisation in clay suspensions	P4 430	100 Hz - 0.1 GHz	Comparisons of an equivalent circuit, Debye-relaxation & mixture model to impedance, permittivity & conductive spectra of Ca- & Na-sat. Montmorillonite DDL : 1...10 kHz; MW: 0.1...1 MHz
Application of mixture formulas to mixtures with flattened & closely packed inclusions	S2.4 54	1 - 10 ⁶ MHz	Maxwell Garnett's mixture formula gave the best results
Permittivity calculation of moist sandy-clayey soils	P5 438	1 - 100 MHz	Model: distribution of water between clay and soil & thickness of layers based on Maxwell Garnett's formula and used for MW effects
Model of complex permittivity of paper	S2.5 62	1 - 10 GHz	Paper layer consists of statistically distributed cellulose fibre-cylinders; Water can be accumulated inside and outside of fibres; conformity between model and experiments

DRS - Dielectric relaxation spectroscopy
XPS - X-ray photoelectron spectroscopy
IGC - Inverse gas chromatography
 ϵ_r - rel. permittivity, dielectric constant

MC - moisture content
MW - Maxwell Wagner effect
DDL - diffuse double layer polarisation
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3 DIELECTRIC PROPERTIES OF BIOLOGICAL SUBSTANCES

Subject <i>Comments</i>	Paper Page	Method Frequency range	Experiments - Results
Dielectric properties of biological materials	S3.1 73	S & J - Band	Application of cavity perturbation technique for determination of complex permittivity of pancreatic juice & stone, chicken bile
Reflection technique for determination of density, moisture & stage decay in wood	S3.2 79	10.7 GHz	Reflection type wood-meter: for routine inspection - 4 prototypes errors: $\pm 2\%$ MC; $\pm 3\%$ density
Wood properties at different MC (heating process) <i>Spruce, beech, oak</i>	S3.3 88	2 - 3 GHz	Complex permittivity is influenced by orientation of annual rings, MC, density, knotholes
Biomass analysis, toxic sensitivity of cells using impedance spectroscopy	S3.4 93	- 100 MHz	Use of dielectric spectroscopy to monitor cell growth in suspensions; alteration of cell concentrations cause changes of dielectric properties.

4 MEASUREMENT METHODS

Subject Comments	Paper Page	Method Frequency range	Experiments - Results
Multivariate methods in microwave aquametry	S4.1 103	0.4 – 6 GHz 10.36 – 18 GHz	Important calibration results by using dielectric spectroscopy & multivariate data analysis PCA, PLS, ANN.
New function for density independent moisture measurement	S4.2 111	9 & 12 GHz	Using dielectric constants for density independent moisture measurement; experimental results with waveguides
Universal calibration for industrial microwave moisture sensors	S4.3 117	9.46 & 14.2 GHz	Universal calibration for wet granular materials with significant structural & compositional differences; crosschecked with transmission measurements
Resonator moisture meter with digital signal processing <i>Use of fringing field resonators</i>	S4.4 125	2.45 GHz	Use of multivariate data analysis in combination with phase curve leads to better results for density independent calibration
Determination of water content independent of its permittivity	P6 446	10 & 37.5 GHz	Method based on the dispersions properties of monitored substances (determination of permittivity at 2 frequencies) Water content in oil independent of type.

5 SENSORS

Subject Comments	Paper Page	Method Frequency range	Experiments - Results
Microstrip sensors used in microwave aquametry	S5.1 135	1 – 10 GHz	Microstrip radiating sensors & antennas; near field experiments & monitoring of particleboards; New: active integrated antennas, photonic band gap patch antennas
Moisture distribution using TDR	S5.2 143	TDR-Imaging	New technique for 2D MC- distribution in a composite material using CG-based inversion
Microstrip resonator technique for moisture / permittivity measurement	S5.3 151	Spectral Domain Analysis 8.4 – 10.2 GHz	Determination of complex permittivity using spectral domain analysis of multi-layer microstrip embedded in a dielectric cover
One sided moisture sensors	156		Open ended types: induct.coupled $\lambda/4$ resonator; T-junction $\lambda/4$ coax line, $\lambda/2$ microstrip resonator
Integrated network analyser module for microwave moisture sensors	S5.5 165	Ultra wideband principle 5 GHz	Can replace NWA or TDR in microwave sensors; using of MLBS-signals simplification of measurement system & application of digital circuit concept (ASIC)
Construction & assessment of a coax-capacitor for dielectric grain measurements	S10.4 403	< 5 MHz	Analysis of capacitive meas. Methods; coax capacitor for determination of dielectric properties of grains

Subject Comments	Paper Page	Method Frequency range	Experiments - Results
Sample area of TDR-Probes in proximity to sharp dielectric permittivity boundaries	S5.6 173	TDR	Permittivity is a function of probe geometry & interface location; the spatial TDR-probe sensitivity is a function of distribution of dielectric permittivities in transverse planes
Conversion models of open coax-probes	S5.7 185	FDTD	Analysis of the conversion stability due to imperfect contact of open ended coaxprobe models; (antenna model, capacitive model, Misra model, virtually conical cable m.)
Microstrip sensor for measuring sand water content & ion conductivity	P8 462	100 - 600 MHz 3 GHz	Detection of MC & ion conductivity ~ insertion loss in MW & RF range; MW- & RF microstrip sensors
Modular MOIST-System Portable setup contains 5 sensing heads, 2 portable & 1 online control units	P9 468	2.45 GHz	Selection of sensing heads with different measuring principles for different penetration depths; applications for many moisture problems
Portable NMR-system in one-sided access technique	P14 500	NMR	Content & mobility of H in the material; linear distribution of MC & moisture mobility; depth profiling of MC

PCA – principal component analysis
ANN – Artificial neural networks
FDTD – Frequency domain, Time domain
RF – radio frequency

PLS – partial least squares
CG – conjugate gradient
MW – microwave
NMR - nuclear magnetic resonance

6 APPLICATION OF METHODS AND SENSORS TO AGRICULTURAL PRODUCTS AND FOODSTUFFS

Subject Comments	Paper Page	Method Frequency range	Experiments - Results
Broadband free-space MW wheat permittivity measurements	S6.1 195	3 – 13 GHz	Results for ϵ_r for different kinds of wheat; $\tan \delta = f(\sigma)$; ionic conductivity depends on local growing conditions, season, variety of wheat
Permittivity of rice grain from electromagnetic scattering	S6.2 203	0.6 GHz, 3.84 GHz	Vector FEM for the permittivity of rice using scattered far field radiation
Permittivity of food materials dependent on frequency & temperature (coax-probe)	S6.3 211	27, 40, 915, 1800 MHz 50 MHz – 20 GHz	Permittivity measurements of liquid, semisolid & pulverised food material versus frequency & temperature
Composition determination of foodstuffs using MW dielectra spectra and ANN	S6.4 217	0.35 – 5.3 GHz	ANN allow composition det. with higher accuracy compared to PCA or PCR (efforts for design & training are higher)
Do MW & IR-dryer measure the MC of foodstuffs?	S6.5 224	MW & IR-drying	MW & IR-drying more effective methods than convective drying; results do not match the results of WC of Karl-Fischer titration

Subject Comments	Paper Page	Method Frequency range	Experiments - Results
Process control using microwave moisture analyser	P15 508	MW-drying	Comparison of MW-drying to oven-drying applications of MW moisture analyser
Influence of some electrical parameters on grain drying process	P16 509	Drying at 2.45 GHz	MW-experiments: moist crops have a dominant ion polarisation; drying rate depends on relation between electric field strength & kernel overall moisture gradient

σ - ionic conductivity

FEM – finite element model

WC – water content

$\tan \delta$ - loss factor

PCR – principal component regression

7 APPLICATION OF METHODS AND SENSORS FOR CIVIL ENGINEERING

Subject Comments	Paper Page	Method Frequency range	Experiments - Results
Free space moisture profile measurement <i>Moisture sensing applications for process control</i>	S7.1 235	2.45 GHz; 10 GHz	Evaluation of reflection and /or transmission coefficient of moist material; Retrieval of the moisture profile of a building material presenting a non-uniform moisture distribution
Characterisation of ions relevant to concrete <i>in Cements & test building</i>	P7 454	30 kHz – 40 GHz	Ions show a characteristic behaviour ; can be separated from moisture; ion influence can be minimised; optimisation of moist. sensors
Dielectric measurement of mortar: Curing time dependency of relaxation spectra of hydrated water / <i>Method for non-destructive testing</i>	S7.2 243	1 GHz	Through the curing time relaxation curve was shifted to lower frequencies; C-H-S gel grows, mobility of structured water decreases (consolidation process); ϵ_r for submerged-mortar blocks was dependent on the compressive strength
Monitoring free water content in hydrating cement paste by a microwave impulse technique <i>Method to the monitoring of residual MC in early hydration stages of cement paste</i>	S7.3 251	Impulse method 7 – 8 GHz Pulse width 150-250 ps	The fastest decrease of res. MC coincides with early stages of hardening process, i.e with the time period between the end of setting & the moment when the first measurable mechanical parameters are obtained
Monitoring moisture content with an embedded transmission line / <i>Sensor placed in fresh cast concrete or embedded within a porous medium</i>	S7.4 259	1 GHz	Results: Determination of moisture transfer between porous media is important for reliable MC measurements
Reliability of Trime-TDR-sensors for determination of MC in pure & contaminated concrete	S7.5 266	TDR	Trime-TDR-technique yield to reproducible results for moisture measurement in concrete; differences in absorption between pure & contaminated material are shown

Subject Comments	Paper Page	Method Frequency range	Experiments - Results
Complex permittivity of building materials dependent on MC, salt content, temperature	S7.6 274	2.45 GHz -10°C - 50°C	Permittivity of moist building materials depends on MC, salt content & temperature (Lime-sandstone, bricks, sandstone)
Moisture mapping getting 2D & 3D moisture distribution by MW measurements	S7.7 282	2.45 GHz	Lateral moisture distributions & MC values in z-dimension (2D) by using sensing heads of different penetration depth; application of a new MW-endoscope type

8 METHODS AND SENSORS IN PROCESS ENGINEERING

Subject Comments	Paper Page	Method Frequency range	Experiments - Results
Permanent downhole MW sensor for the local measurement of the WC of the fluid produced in an oilwell	S8.1 293	0.5 – 1 GHz	WC watercut sensor for use downhole in smart oil wells; semisectorial cavity resonator; requirements: high temperature range, pressure, limited space, low power
Low frequency online MW moisture analyser for minerals & process industries	S8.2 301	0.8 – 2.5 GHz	Design criteria & hardware requirements for high loss material; digital control for high phase accuracy & dynamic range; results on thick depths of black coal & ore concentrates
Slot-coupled ring resonator for MC measurement in an industrial environment	S8.3 308	1.05 – 1.140 GHz	MC measurement of ceramic powder with high reproducibility in an ind. environment; microstrip ring resonator; sensor design: full wave numerical approach with a simple equivalent circuit for calibrations
Determination of density & moisture distribution in chip boards with one-sided NMR	S8.4 316	NMR	Measurement of depth-profiles of moisture and density in wood panels; errors: wood moisture ~ 0.3 – 1.0 % MC, wood density ~ 8 – 23 kg/m ³ ; depth resolution ~ 1 mm

9 MOISTURE CONTENT DETERMINATION IN SOILS AND MINERALS

Subject Comments	Paper Page	Method Frequency range	Experiments - Results
Electromagnetic wave measurements of soil MC: a state of the art	S9.1 327	TDR, GPR, remote radar capacit. methods	Comparison of penetration depths of different measurement methods: TDR & capacitance methods, GPR, remote radar, passive MW methods (1 GHz)
Dielectric relaxation time spectra of aqueous montmorillonite clay suspensions	S9.2 336	100 Hz – 15 MHz	Expectation maximisation algorithm for obtaining dielectric relaxation time distributions from impedance spectra data
Monitoring of spatial soil water distribution on a full-scale dike model	S9.3 343	TDR	Development of a reconstruction algorithm for the use of full TDR information content example: dike model & flood simulation

Subject Comments	Paper Page	Method Frequency range	Experiments - Results
In-situ TDS in soils: problems, possibilities, solutions	S9.4 351	TDS	General principle of TDS; signal processing; experimental setup; results for reference material & natural soil; improved accuracy
Radio wave absorption coefficient in sandy & clayey soils	S9.5 359	0.13 – 37 GHz	Measurements of radiowave absorption coefficient in soils versus MC at seven frequencies
Mapping soil MC with GPR	S9.6 366	GPR	Soil permittivity: using ground wave velocity; error: $0.02-0.05\text{m}^3/\text{m}^3$ by irrigation spatial pattern in soil MC; GPR can recover this pattern
Control of moisture of rocks by methods of MW aquametry	S9.7 374	10.5; 18 GHz	Lab. & online resonator moisture meters Application in mining; industrial tests at rocks & chemical materials
MC and conductivity of porous materials by using TDR	P10 469	TDR	TDR for measurement of MC & σ of soils; errors MC: $10^{-2}\text{cm}^3/\text{cm}^3$; σ : $4 \cdot 10^{-2} \text{ mS/cm}$
Inversion of dielectric prop. of diesel contaminated sands; modelling of GPR-measurements on contaminated sites	P11 477	GPR	Hydrocarbon contamination of soil detected by GPR ; reliable estimate of contamination is open; experiments for solution by using radargrams and modelling tools
MC determination with GPR	P12 484	GPR	2 methods: migration of hyperbolas (non-destructive) & method using guided wave (borehole) better resolution

GPR – ground penetrating radar

TDS – time domain spectroscopy

10 REMOTE SENSING

Subject Comments	Paper Page	Method Frequency / Time Domain	Experiments - Results
Electrostatic multipole to assess spatial distribution of <i>In Situ</i> MC of vegetation canopies	S10.1 383	450 kHz	Electrostatic multipole for estimation MC of horizontal canopy layers related to biomass; experiments on a wheat crop; estimation of spike & stem MC
Free space measurement techniques for leak detection of underground pipes & vegetable detection	S10.2 390	TDR	Free space measurement & analysis of TDR-data on underground objects; underground vegetables are different from other dielectric objects; application: agriculture & industry
Design of test bed for standard radar image Monitoring System of the ϵ_r distribution in GPR test bed using 42 open ended coax probes; depth: 0.5 - 6m	P13 492 S10.3 395	GPR 0.3 MHz - 1.5 GHz	Quantitative analysis of parameter in test bed for standardised radar images of underground anomalies; new calibration method; analysis of underground situation, environmental pollution, safety of concrete structures

SUMMARY

It is my great pleasure to thank all attendees for the papers, posters, and exhibits. It was presented the results of research, development, and application of Microwave Aquametry all over the world.

The analysis of water in its different states of binding and in its different mixtures are the basis for the identification of material properties. The interaction of water molecules in the electromagnetic field permits the measurement of water in the structure of other materials by using dielectric methods. Model systems and mixture theory help to calculate the contents of air, water and dry material, and to reduce the efforts for the measurements.

A lot of investigations were presented in the Sessions 1 'Dielectric Properties of Aqueous Materials' and 2 'Water in Model Systems and Mixture Theory' some of them should be mentioned:

- Dielectric spectra of aqueous systems and their characteristic differences to the water spectrum in the frequency domain up to 40 GHz.
- Broadband dielectric relaxation spectroscopy and thermally stimulated depolarisation current techniques were employed to investigate molecular mobility in hydrogels in the frequency domain 0.01 Hz - 1 GHz.
- Determination of dielectric constants of liquids in the frequency range 75 – 110 GHz.
- The dielectric spectroscopy (20 Hz - 1 MHz) method was applied to the investigation of water absorbed on the inner surface of porous glass.
- A new model accounting for the temperature dependence of bound and free water describes permittivity of the total water-phase. Particle shape (geometrical) and bound water effects on permittivity predictions are accounted for in a three-phase dielectric mixing model (TDR, 0.2 - 1 GHz; 270 - 330 K).
- Modelling Maxwell-Wagner and diffuse double layer polarisation in frequency range 100 Hz - 100 MHz by using 4 models.
- Development of a model for mixtures with flattened and closely packed inclusions. Model is based on Maxwell-Garnett's formula and shows the distribution of water between clay, soil, and layer thickness. It can be used to describe Maxwell-Wagner effects in the frequency range 1 - 100 MHz.
- During the calculation of the complex permittivity of paper it was supposed that the paper layer consisted of statistically distributed cellulose fibre-cylinders. Water can be accumulated inside and outside of fibres. Experiments confirmed the model (1 - 10 GHz).

In Session 3 'Dielectric Properties of Biological Substances' the following experiments were presented:

- Analysis of biomass and cell growth by using dielectric measuring methods.
- Dielectric measurements of wood with type specific density and moisture and presentation of moisture meter to wood.
- Determination of complex permittivity of body fluids like pancreatic juice and chicken bile.

Session 4 'Measurement Methods' shows:

- Introduction of new calibrating methods, by using principal components, regressions, and artificial neural networks.
- Application and optimisation of methods to the density independent measurement.

Sensors and measurement methods were introduced in Session 5:

- Microstrip sensors and antennas; near field experiments to moisture measurement and monitoring of particle board production.
- New TDR-imaging technique for 2-D moisture distribution in a composite material.
- Presentation of an integrated network analyser basing on an ultra-wide band principle.
- Modular microwave MOIST system contains 5 sensing heads, 2 portable, and online control unit.
- Portable NMR-system in one-sided access technique for determination of moisture distribution and depth profiling.

Session 6 'Application of Methods and Sensors to Agricultural Material and Foodstuffs' presents:

- Application of broadband free-space microwave wheat permittivity measurement.
- Determination of rice grain by using scattered signals.
- Permittivity of food material dependent on frequency and temperature.
- Composition determination of foodstuffs using microwave dielectric spectra and artificial neural networks.
- Methods of microwave drying and their influence on accurate moisture determination of foodstuffs.

In Session 7 'Application of Methods and Sensors for Civil Engineering' investigations are not only relevant to building materials, but also moisture distributions in buildings:

- Free space moisture profile measurement of building materials at 2.45 and 10 GHz.
- Characterisation of ions relevant to concrete in the frequency range 30 kHz - 40 GHz.
- Mortar curing time dependent on the relaxation spectra of hydrated water.
- Monitoring free water content in hydrating cement paste by microwave impulse technique.
- Reliability of TDR sensors for determination of moisture content in pure and contaminated concrete.
- Moisture mapping 2D and 3D moisture distribution by microwave measurements.

In process engineering (Session 8) the following methods and sensors are applied:

- Presentation of a permanent downhole microwave sensor for the local measurement of the water content of the fluid produced in an oilwell.
- Low frequency online microwave moisture analyser for minerals and process industry.
- Moisture measurement of ceramic powder with high reproducibility in an industrial environment.
- Determination of density and moisture distribution in chip boards with one-sided NMR.

Session 9 'Moisture Content Determination in Soils and Minerals'

Increasingly the time domain is used in connection with mathematical models for measurement in soils and for imaging moisture profiles:

- State of the art of electromagnetic wave measurements of soil moisture content.
- Dielectric relaxation time spectra of aqueous montmorillonite clay suspensions.
- Monitoring of spatial soil water distribution on a full scale dike model.
- Time domain spectroscopy and their application in soils.
- Mapping of soil moisture content using GPR.
- Control of moisture of rocks by methods of microwave aquametry.

- Determination of moisture content and conductivity with TDR methods.
- Dielectric properties of diesel contaminated sands.

Session 10 'Remote Sensing' is used not only for exploration of earth surface, but also for detection of buried objects, and moisture of vegetation canopies:

- Electrostatic multipole for estimation of moisture content of horizontal vegetation canopy layers.
- Free space measurement techniques for leak detection of underground pipes and vegetable detection.
- Design of a test bed for standard radar image and monitoring system for of dielectric constant distribution.

The measuring instruments used in oral presentations, posters, and exhibits operate in the following frequency or time domains:

Method / Frequency Range	Number of Papers and Exhibits
Frequency domain 10^{-2} Hz - 110 GHz	51
0 - 100 MHz	6
0 - 1.9 GHz	13
up to 10 GHz	33
up to 40 GHz	9
up to 110 GHz	1
2.45 GHz (Microwave drying)	4
Other single frequency ISM	12
2 frequencies	5
Narrow frequency band	5
Time domain	13
Radar	6
NMR	2

It means that the whole frequency spectrum from 0.01 Hz - 300 GHz is used for dielectric measurement methods, but the microwave range up to 10 GHz dominates. Multiparameter methods as well as methods of principal components and artificial neural networks will be used to carry out density independent measurements. Increasingly the imaging of moisture distributions will be realised by using time domain methods, ground penetrating radar and microwave instruments connected with various data processing. Applications which served the protection of the environment were performed on diesel contaminated soils and on the monitoring of spatial water distribution on a full-scale dike model.

The interdisciplinary contributions of the conference covered many fields such as physics, technology, electrotechnical engineering, biological and forest engineering, environmental physics, food engineering, civil, geotechnical, geological, and geophysical engineering, oil, coal, and mining industry, hydrology, chemistry and biochemistry, medicine, pharmacy. The participating scientists work at institutes for horticulture, soils and biometeorology,

computing and biometrics, biomaterials, agriculture, meteorology and climate research, material research, geo-ecological research, biodiversity and ecosystems dynamics, physical geography and soil science, soil and rock mechanics, agrophysics, building and climatology, and nondestructive testing.

We are really glad to get support and cooperation from so many disciplines. A new society of international scientists, engineers, and manufacturers should not be limited to moisture measurement. Investigations of electromagnetic material properties, cancer detection in medicine and in veterinary medicine, water and air pollution, determination of physical properties such as, density, mass, consistency, concentration of composites, quality and authenticity of foodstuffs, and standardisation of these measurement methods present a very broad work area.

We appreciate the exhibition of moisture measurement instruments on the occasion of the 4th International Conference on Electromagnetic Wave Interaction with Water and Moist Substances, and we thank all exhibitors for their advertising, which supported the conference.

The panel discussion gave valuable advices for a better introduction of Microwave Aquametry into different application fields.

During the time of the conference scientists and experts of different fields exchanged their experiences and discussed about cooperations for the future.

We acknowledge once more the support of Deutsche Forschungsgemeinschaft and the Thuringian Ministry for Science, Research, and Art.

We thank all colleagues of MFPA Weimar and Mrs. Rieger for their help during the realisation of the conference.

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Klaus Kupfer
Conference Chair