

Chairman's Welcome Message

The exchange of ideas and concepts across different scientific fields is an essential first step to find innovative solutions for the future and the current problems of humanity. The aspired aim of the International Workshop on Impedance Spectroscopy (IWIS) is to bring together innovative and experienced scientists from different countries to discuss methods, instrumentation, and results of the recent research work in electrochemistry material science, biology and medicine, electronics and sensors. The Advanced School on Impedance Spectroscopy (ASIS), which takes place for the fourth time this year, provides a good overview of the basics around the method and makes it more accessible for young scientists. An exhibition informs about the latest news on the measurement equipment and devices. These are the main components of this annual international workshop taking place at Technische Universität Chemnitz.

In its 14th edition, the IWIS includes 46 contributions from 15 countries in 11 sessions, 5 plenary talks, 2 workshops and 7 tutorials. The peer-reviewed contributions highlight new advances and present different approaches to impedance spectroscopy, including modeling, measurement and applications.

This year's IWIS is a continuation of the brilliance of the IEEE Technical committee IM-TC 2 on Impedance Spectroscopy. In its second year, TC2 is promoting Impedance Spectroscopy and standards within the IEEE community worldwide.

The organization of the workshop has requested a considerable effort from the organizing team of the chair for measurement and sensor technology, which makes it possible to organize this international event this year online within Technische Universität Chemnitz.

We thank the IEEE Instrumentation and Measurement Society for supporting the Advanced School on Impedance Spectroscopy and the IEEE Instrumentation and Measurement Chapter Germany for the assistance of the event. The workshop is co-organized by the Chemnitz School of Metrology (CSM e.V.), whose support for the event is highly acknowledged.

We would like to thank you for choosing IWIS 2021.

Prof. Olfa Kanoun & Prof. Abdelhamid Errachid
General Chairs

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General Information

The City of Chemnitz

Chemnitz has its unique story - of ground-breaking inventions in automotive engineering, mechanical engineering or the textile industry as well as of courageous companies like Richard Hartmann, Carl Gottlieb Haubold or Louis Schönherr. As a modern industrial city, Chemnitz has continued to write its history and is today one of the fastest-growing cities in Germany. The city is a center of technology focusing on the automotive and supplier industries, information technology and mechanical and plant engineering.



Industry Museum,
(©www.chemnitz2025.de)



Rathaus, Neumarkt (©CWE - Chemnitz)

Going down their own path, experiencing new adventures and inventions - this recipe makes the city Chemnitz and its people successful: thousands of patented ideas like the thermos flask or the first mild detergent were conceived

here. Today, as an essential link in the global manufacturing chain, Chemnitz produces excellent machines and production facilities for the whole world.

A European selection jury has named the German city of Chemnitz the European Capital of Culture for 2025. The Saxonian city beat four other German cities on the shortlist: Hannover, Hildesheim, Magdeburg and Nuremberg.



Logo of Chemnitz as European capital of culture (©www.chemnitz2025.de)



Residents of Chemnitz celebrate the nomination of Chemnitz as the European Capital of Culture 2025. (©Jan Woitas/dpa)

Tradition and modernity are also reflected in exciting urban contrasts. Unique evidence like “das Bauhaus” and “die neue Sachlichkeit” or the Kaßberg, some of the largest intact areas of Wilhelminian style architecture in Europe, are deeply loved by the architecture fans. Just like Chemnitz city center, which has been redesigned over the past 20 years by internationally renowned architects such as Helmut Jahn, Hans Kollhoff and Christoph Ingenhoven.

For lovers of the fine arts there is a lot to discover in Chemnitz: For example, the Chemnitz Art Collections or the Gunzenhauser Museum, which houses one of the most impressive collections of classical modern art. Meanwhile, the Saxon



Buildings in Jugendstyle in the famous Chemnitz-Kaßberg (4.5 km² protected area as a historic monument), ([©www.chemnitz.de](http://www.chemnitz.de))

Industrial Museum traces its history and present. The Municipal Theatres with the Robert-Schumann-Philharmonie attract visitors from all over Germany.

A side-trip to the more than 100-year-old town hall is also worthwhile: the monumental Klinger-mural “Arbeit - Wohlstand - Schönheit” can be admired in the town council hall. The council hall is adorned with the work “Die Abwäng” by Neo Rauch, one of the most important contemporary artists.

Those who simply want to relax will also find a place in Chemnitz: recreation islands such as the castle pond with the adjoining kitchen forest invite you to stroll and linger as well as the historic city park along Chemnitz.

Let Chemnitz surprise you, go to discover the city by yourself - it's worth it!

Conference Venue

The International Workshop on Impedance Spectroscopy will take place online using the Zoom platform.

Sponsors

The workshop is supported by:

- School of Metrology CSM e.V.



- IEEE Instrumentation & Measurement Society



- IEEE IM Chapter Germany Section



- IEEE EMB Chapter Germany Section



- IEEE Technical committee IM-TC 2 on Impedance Spectroscopy



- The main sponsors from industry:



ASIS Program

Wednesday, September 29th, 2021 Learning Day

- 09:00 - 10:00 **Tutorial 1**
Basics on Electrochemistry, Phase Boundaries and Cell Potential
Prof. Roman Gruden, Industrial Automation, Duale Hochschule Baden-Württemberg Stuttgart, Germany
- 10:00 - 11:00 **Tutorial 2**
Microfluidic impedance cytometry: basic principles and applications
Prof. Federica Caselli, Department of Civil Engineering and Computer Science, University of Rome Tor Vergata, Rome, Italy
- 11:00 - 12:00 **Tutorial 3**
What can we learn from impedance in GHz-range?
Prof. Uwe Pliquet, Institut für Bioprozess- und Analysenmesstechnik e.V., Heiligenstadt, Germany
- 12:00 - 13:00 **Lunch Break**
- 13:00 - 14:00 **Tutorial 4**
Impedance Basics: Choosing the Instrumentation
Dipl. phys. Martin Bulst, Sciospec, Bennewitz, Germany
- 14:00 - 15:00 **Tutorial 5**
Possible Pitfalls Measuring High- and Lowohmic Objects
Dr. Werner Strunz, Zahner elektrik, Kronach, Germany
- 15:00 - 16:00 **Tutorial 6**
Constant Phase Element: Is it Real?
Prof. Andrzej Lasia, Emeritus Professor at the Chemistry Department, Université de Sherbrooke, Québec, Canada

- 16:00 - 17:00 **Tutorial 7**
Electrocatalytic, Dielectric and Supercapacitor Performances of Iron Oxide Nanoparticles Based Devices Probed by Impedance Spectroscopy
Prof. Leonardo Giordano Paterno, Laboratory of Research on Polymers and Nanomaterials - LABPOLN, Institute of Chemistry, University of Brasilia, Brazil
- 17:00 - 18:00 **IEEE TC-2 Impedance Spectroscopy Meeting**

IWIS Program

Thursday, September 30th, 2021

08:30 – 09:00

Opening

Chairs: Prof. Olfa Kanoun & Prof. Abdelhamid Errachid

09:00 – 10:00

Plenary Talk 1

Chair: Prof. Olfa Kanoun

The distribution of relaxation times for the analysis of electrochemical impedance spectra: a probabilistic approach;
Prof. Francesco Ciucci

10:00 - 10:15

Break

10:15 – 11:15

Plenary Talk 2

Chair: Prof. Abdelhamid Errachid

Induction spectroscopy for non-destructive testing, metal characterisation and industrial scale bio-impedance measurement;
Prof. Anthony Peyton with Dr. Michael O'Toole

Session 1A - Fundamentals

Chair: Prof. Fancesco Ciucci

11:15 – 12:00

- Extension of frequency domain: how zero-padding can stabilize Distribution of Relaxation Times; *Davide Clematis et al.*
- DRT-based modelling framework for Li-ion cells; *Pietro Iurilli et al.*
- Model Equation for Cable Reflections; *Dhia Haddad et al.*

Session 1B - Materials (1)

Chair: Prof. Anthony Peyton

11:15 – 12:00

- Characterization of electronic transport properties of organic semi-conductors with impedance spectroscopy; *Hiro Yoshi Naito*
- In Situ Monitoring of HKUST-1 Thin Film Growth by Impedance Spectroscopy; *Benedikt Sapotta et al.*
- Studying the barrier quality of ALD oxide layers; *Heike Wünscher et al.*

- 12:00 – 13:00 **Lunch Break**
- 13:00 – 14:00 **Workshop 1: Innovation in Impedance Instrumentation**
- Moderator: Dr.-Ing. Thomas Keutel*
- This session is brought to you by::
- Sciospec;
 - rhd instruments;
 - Rutronik;
- 14:00 – 15:00 **Workshop 2: Success stories**
- Moderator: Dr.-Ing. Thomas Keutel*
- Aiming for new experimental horizons in solid state electrochemistry - the CompreDrive by rhd instruments; *rhd instruments*
 - The OrganoTEER® - A sensitive TEER measurement platform for high-throughput screening of Organs-on-Chips; *MIMETRS*
 - Electrical impedance spectroscopy for ex-vivo analysis of human thrombi from acute ischemic stroke patients; *SENSOME*
 - Impedance Emulation with Hybrid Energy Storage System in Mobilty Applications; *Rutronik*
 - Keysight Technologies;
- 15:00 – 15:30 **Workshop 3: Discussion**
- Moderator: Dr.-Ing. Thomas Keutel*
- 15:30 – 15:45 **Break**
- 15:45 – 16:45 **Plenary Talk 3**
- Chair: Prof. Uwe Pliquett
 Medicine-based Engineering: the case of Bioimpedance;
Prof. Franco Simini

Session 2A - Sciospec Special Session: Bioimpedance (1)

Chair: Prof. Franco Simini

- 16:45 – 18:00
- Conductivity and permittivity characterization of post mortem porcine brain in situ; *Lucas Poßner et al.*
 - Challenges of applying impedance spectroscopy to characterize electrical conductive wood adhesives; *Christoph Winkler et al.*
 - Reversible electroadsorption/-desorption of ionizable micropollutants from water: perfluoroalkyl acids as target compounds; *Navid Saeidi et al.*
 - Impedance spectroscopy monitoring of magnetic field effects on yeast cells; *Michal Teplan et al.*

Session 2B - TIRAM Special Session: Electrical impedance tomography

Chair: Prof. Federica Caselli

- 16:45 – 17:30
- Forward Modelling and Image Reconstruction with Post-processing for Human Thorax Imaging based on Electrical Impedance Tomography Measurements; *Hamdi Haddad et al.*
 - Two-Dimensional Forward Modeling using COMSOL Multiphysics for Human Thorax Imaging Based on Electrical Impedance; *Oumaima Bader et al.*
 - 3D Image Reconstruction based on Electrical Impedance Tomography Measurements using a Gauss-Newton Algorithm; *Mariam Hafsa et al.*
 - Parametric Study of Electrical Impedance Tomography Measurements applied on the Human Forearm using Comsol Multiphysics; *Bilel Ben Atitallah et al.*

Session 2C - CRC Special session: Body attached sensors

Chair: Prof. Mahdi Guerrazi



- 16:45 – 17:30
- Epileptic Seizure Motion Classification based on sEMG and Artificial Neural Network; *Achraf Djemal et al.*
 - Comparative of ELM optimization in the state of the art; *Tayssir Chouikh et al.*
 - Comparative of Different Salp Swarm Algorithm Improvements for Feature Selection Application; *Ayoub Choura et al.*
 - A Fast Crest-Factor Optimization for Broadband Multisine Signal based on Evolutionary Game Theory; *Ahmed Yahia Kallel et al.*

18:00 – 19:00

Special Session BISMON: Generic Platform for the Design of Bioimpedance Spectrometer for Non-Invasive Biological Tissue and Personal Health Monitoring (DAAD)

Chair: Prof. Olfa Kanoun & Dr.-Ing. Dhouha Bouchaala;

- Opening; *Prof. O. Kanoun*
- Potential of Impedance Based Method for Medical Applications; *Dr. D. Bouchaala*
- Design of Dry Electrodes Based on MWCNT for Medical Applications; *Sc. C. Naggara*
- Design of Bioimpedance Measurement System for Hand Gesture Recognition; *N. Ammar*
- Damped Linear Kramers-Kronig Solution as a Correction Tool for Noisy Impedance Spectra; *M. Sc. A.Y. Kallel*
- Epilepsy Diagnosis Based on sEMG Signal and Artificial Neural Network; *M. Sc. A. Djemal*
- Wireless Sensor Networks for Muscle Contraction Tracking; *M. Sc. H. Hillara*
- Development of High Performance Piezoelectric Nanogenerator for Self-Powered Sensor in Medical Applications; *M. Sc. S. Missaoui*

Friday, October 1st, 2021

09:00 – 10:00 **Plenary Talk 4**
Chair: Prof. Olfa Kanoun
Impedance spectroscopy of memory effects. From halide perovskite memristors to artificial neurons; *Prof. Juan Bisquert*

10:00 – 10:15 **Break**

10:15 – 11:15 **Plenary Talk 5**
Chair: Prof. Jörg Himmel
Insights into Electrical Transport in Oxide Glasses and Glass-Ceramics from Solid State Impedance Spectroscopy Measurements; *Prof. Luka Pavić*

Session 3A - Measurement Systems

Chair: Prof. Juan Bisquert

- 11:15 – 12:00
- Fast data acquisition of complex impedance spectra of organic light emitting diodes using time-stretched pulses; *Atsushi Okada et al.*
 - Capacitive-Coupling Impedance Spectroscopy Using a Non-Sinusoidal Switchable Oscillator; *Tomiharu Yamaguchi et al.*
 - Microfluidic-Based Electrical Impedance Spectroscopy System Using Multilevel Lamination of Dry Film Photoresist; *Yuan Cao et al.*

Session 3B - Energy

Chair: Prof. Luka Pavić

- 11:15 – 12:00
- Oxygen Transport Impedance in a Polymer Electrolyte Membrane Fuel Cell Equivalent Electrical Circuit; *William Ait-Idir et al.*
 - Validation of excitation signals for performing EIS on an embedded solution for Li-Ion Batteries; *Amin I. Fischer et al.*
 - Impact of sulfide based solid electrolyte particle size distribution on the electrochemistry of ASSB via impedance study; *Neelam Yadav et al.*

12:00 – 13:00 **Lunch Break**

Session 4A - Bioimpedance (2)

Chair: Prof. Pasquale Arpaia

- 13:00 – 15:30
- Preliminary investigation of the impact of mechanical stresses on bioimpedance spectroscopy-based insuline bioavailability assessment; *Pasquale Arpaia et al*
 - Investigation and evaluation of biofilm development in forest lakes using bioimpedance spectroscopy; *Lea Stuppi et al*
 - Robust Advanced Sensor System for Determination of Volatile Organic Compounds (VOC); *Andreas Mangler et al*
 - Changes in the Dielectric Spectra of Tumors in a Xenograft Model for Colon Cancer; *Ahmet C. Sabuncu et al*
 - Towards Impedance-based Cancer Detection During Colonoscopies; *Erik Skorina et al*
 - Impedance spectroscopy of glucose solutions in the range from 1 MHz to 1 GHz; *Leonardo Iannucci et al*
 - Early Altered Cells Health Status Detection via Label Free Impedance and Broadband Dielectric Spectroscopy; *Marianna Ambrico et al*
 - Using Electrochemical Impedance Spectroscopy (EIS) to study the in vivo evolution of the electrochemical properties of neural implants; *Valentin Helias et al*
 - Cole-Cole Parameter extraction from Electrical Impedance Spectroscopy for real-time monitoring of vegetal tissue: case study with a single celery stalk; *Soufiane Aouane et al*

Session 4B - Materials (2)

Chair: Prof. Federica Caselli

- 13:00 – 14:00
- Impedance Spectroscopy Analysis of $\text{La}_{0.8}\text{Sr}_{0.2}\text{Fe}_{1-x}\text{Mg}_x\text{O}_3$ Perovskite Material Prepared by Sol-Gel Method; *Ahmad Khalil Yaqubi et al*
 - Dielectric relaxation of iron corrosion products in limestone under saline environment; *Benhui Fan et al*
 - Investigation of flexible composite nanofibers/nanoparticles of sPEEK/PVP/RuO₂; *Ahmad Ayesah et al*
 - B4C and ZnO Based Electrodes for All-in-One Supercapacitor Devices; *Merve Buldu-Aktürk et al*

Session 4C - Sensors

Chair: Prof. Abdelhamid Errachid

- 14:00 – 15:30
- Development of silicon-based micro-sensor for methanol selective discrimination and detection over interfering VOC; *Ibrahim Musa et al*
 - Soft Nanocomposite Pressure Sensors as Smart Seals; *Jose Roberto Bautista-Quijano et al*
 - Copper-Free click chemistry assisted antibodies immobilization for immunosensing of IL-10 cytokine; *Nazha Hilali et al*
 - Electrochemical detection of acetaminophen using phthalocyanine/CeO₂ bilayered electrodes; *Emiliano Gomes et al*
 - Gold nanoparticles embedded in cement paste a change in the polarization resistance by impedance spectroscopy; *Jorge Hernan Quintero Orozco et al*
 - An impedimetric sensor for levothyroxine detection towards point of care applications; *Melinda David et al*

15:30 – 15:45 **Closure**

Publications series

O. Kanoun (Ed.)

Impedance Spectroscopy: Advanced Applications: Battery Research, Bioimpedance, System Design

Vol. 1, ISBN 978-3-11-055892-0, 2018

Progress Reports on Impedance Spectroscopy

Vol. 1, ISBN 978-3-11-044756-9, 2016

Lecture Notes on Impedance Spectroscopy: Measurement, Modeling and Applications

Vol. 5, ISBN 978-1-138-02754-1 (Hbk), 2015

Vol. 4, ISBN 978-1-138-00140-4 (Hbk), 2014

Vol. 3, ISBN 978-0-415-64430-3 (Hbk), 2012

Vol. 2, ISBN 978-0-415-69838-2 (Hbk), 2012

Vol. 1, ISBN 978-0-415-68405-7 (Hbk), 2011

Selected contributions from the IWIS 2022 will be published in the International Journal on Sensors and Instrumentation Systems, Inderscience.