Continuum Modelling with QuickWave software – User Cases of MMAMA and NanoBat projects

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The aim of this project is to accelerate the development of **high efficiency cells** and to have measures to **predict performances** in early stages of prototype production. Where process monitoring of **materials with nanostructures** is necessary, a dielectric resonator is used to translate insights from scanning microwave microscope measurements to fabrication environments. Such dielectric resonators could be directly integrated in production lines for monitoring thin film deposition processes. **An open innovation environment** will make the uptake of the results easier for European industry.

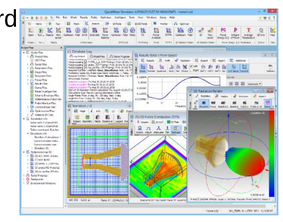
NanoBat project aims to develop a novel nanotechnology toolbox for **quality testing of Li-ion and beyond Lithium batteries** with the potential to redefine battery production in Europe and worldwide. The targeted radio frequency **(RF)-nanoscale techniques** will be faster and more accurately calibrated than existing methods. The project will significantly reduce the costs of battery production thus greatly benefiting the evolving **clean energy and e-mobility** transition in Europe.

Business branches & activities

Electromagnetic & Multiphysics modelling & design software, 3D & BOR 2D tools from QuickWave family

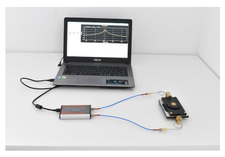
Based on 300+ publications by:
Prof. W. Gwarek, IEEE Fellow, DML, Pioneer Award
Dr. M. Celuch, President of QWED

THE EUROPEAN INFORMATION TECHNOLOGY PRIZE Winner



Text-fixtures for precise material measurements

Based on 300+ publications by Prof. J. Krupka, IEEE Fellow

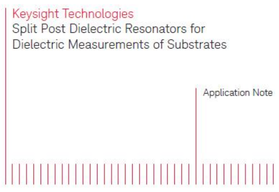



Consultancy & design services based on EM & material characterisation and measurements techniques

team of 10+engineers, 4 PhDs, 2 Profs
key areas: MW power appliances, customised resonators for material measurements, antennas &feeds

Public co- funded research projects

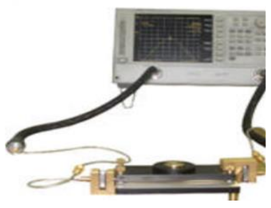
Material measurements



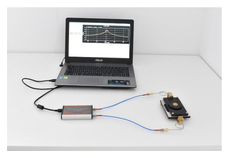
Split-post dielectric resonators for low-loss laminar dielectrics measurements subject of
European Standard IEC 61189-2-721:2015
endorsed by Keysight Technologies Option 003 N1500A

Robust, easy-to-use with:

standard VNA



QWED portable low-cost Q-Meter

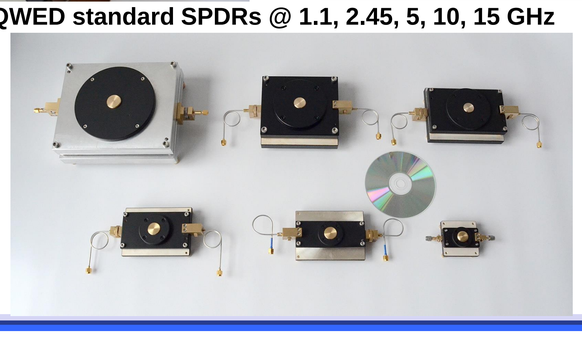


Recent SPDR-based designs for larger surfaces of:

large sheets of glass manual scan @1.9 GHz

semiconductor wafers automatic scan @10 GHz

QWED standard SPDRs @ 1.1, 2.45, 5, 10, 15 GHz

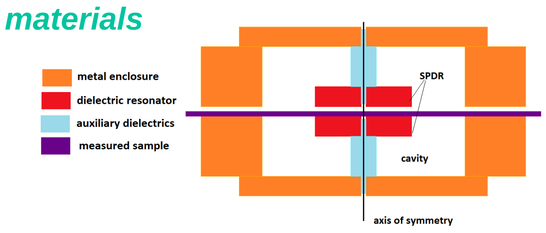


QuickWave

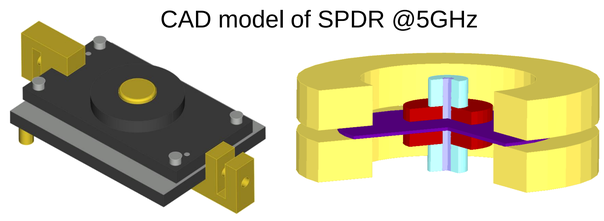
Electromagnetic & Multiphysics modelling software accounting for materials modelling at the continuum level.

Simulation – assisted design of microwave test-fixtures for material measurements

Split-Post Dielectric Resonator method for characterisation of lossy dielectrics and semiconducting materials

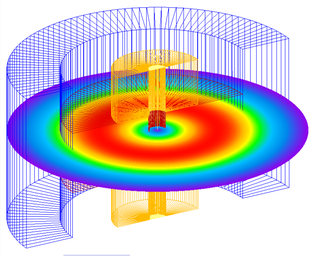
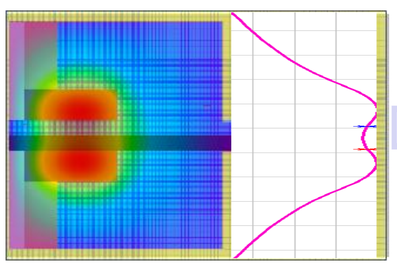


CAD model of SPDR @5GHz

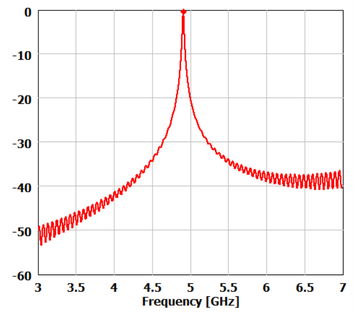


Simulated field distribution in SPDR

Electric field

Material sample interacts with strong electric field, which facilitates parameters extraction of highly-resistive semiconductor materials with application to e.g. photovoltaic cells

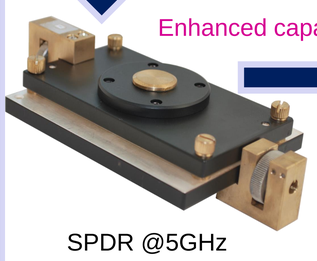


Exemplary |S21| curve for SPDR @5GHz

Measurement device

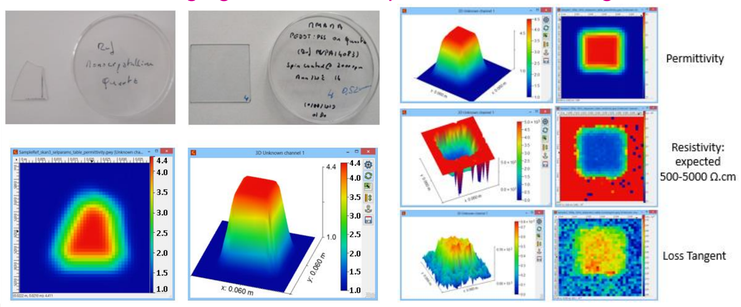
semiconductor wafers automatic scan @10 GHz

Enhanced capabilities



SPDR @5GHz

2D surface imaging - Detection of parameters' inhomogeneities

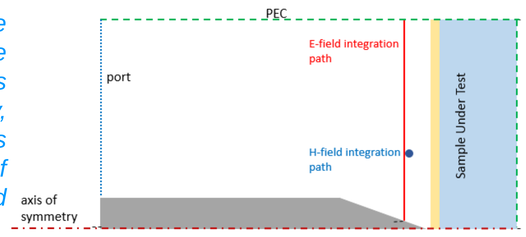


2D permittivity maps obtained with QWED 10GHz scanner

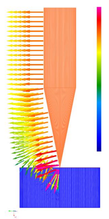
Semiconductor sample: PDOT:PSS deposited on quartz

Scanning Microwave Microscopy (SMM) tip for material characterisation

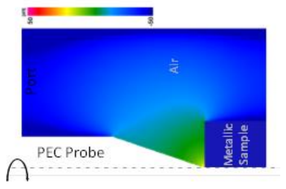
Application of unique QuickWave software package for structures of axial symmetry, enhancing analysis speed by orders of magnitude compared to full 3D problem



Extraction of capacitance of planar capacitors by applying integration procedure to electric and magnetic fields



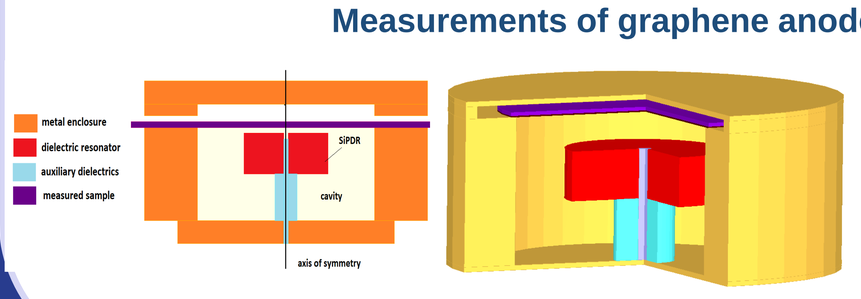
Electric field



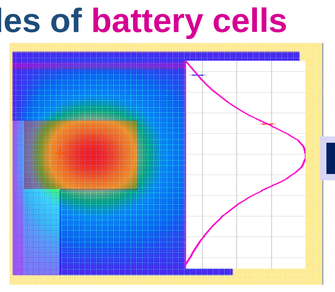
Single-Post Dielectric Resonator method for characterisation of thin conductive sheets

Challenges for the NanoBat project

Measurements of graphene anodes of battery cells



NEW SiPDR configuration for conductive materials



Simulated E-field distribution in the half cross-section

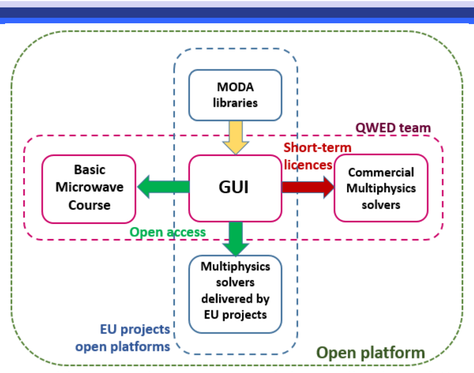
Material sample interacts with weak electric field, which facilitates extraction of conductive materials with application to e.g. battery electrodes

Open environment for modelling

- *Common GUI*
- *Interfaces to various solvers*
- *Assuring FAIR data*
- *Enabling modelling at different levels*

Such an approach will deliver a complete solution allowing for multi-scale multi-physics material analysis from the electronic level, through atomistics and mesoscale to continuum modelling (and possibly also data-based modelling), which eventually enables the analysis of device performance, being of high interest of industry.

Various access rights (open access, licensed access to commercial tools, etc.)



Modelling platform with exemplary commercial contribution of QWED tools

European modelling environment with common Graphic User Interface

Facilitating:
- ✓ *Interoperability*
- ✓ *Software deployment*
- ✓ *Model development*
- ✓ *Enhancing industry impact*

Acknowledgement

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