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seinen Vortrag zur Vorstellung vor dem Fachbereich Physik

über

Nanoscale complex impedance and dielectric properties

Abstract:

A new GHz-AFM (atomic force microscope) was developed in Keysight Labs Linz in 2009 and further extended including measurement hardware, calibration algorithms, data analysis and application workflows[1,2]. The combination of AFM with the vector network analyser (VNA; typically used in telecommunication industry) allows to measure the sample nanoscale topography as well as high- frequency electrical properties. Advanced microwave calibration workflows have been developed to extract complex impedance and permittivity from raw SMM (scanning microwave microscopy) measurements for advanced materials including 2D graphene, high-k oxides, and magnetic samples[3,4]. Due to the capability of the electromagnetic GHz wave to penetrate from the surface into the bulk of the sample, SMM can be used also to selectively measure sub-surface features, as shown on semiconductor devices and single atom-thick dopant layers in silicon used for quantum computing applications[5,6]. Dopant profiling in silicon revealed capacitive properties of the depletion zone of various devices with 10 nm resolution that were compared to 3D electromagnetic modeling.[7,8] Furthermore, the broadband measurement capabilities were developed between 1-20 GHz and were used to characterize bacteria and cells, in particularly the equivalent conductance and parallel capacitance with respect to water dielectric properties[9,10]. In summary, the SMM was developed to achieve highly sensitive (1 aF noise level) and calibrated measurements that are traceable to international metrology standards allowing for advanced materials characterization at the nanoscale.

References: [1]IEEE COMCAS 1 (2009), 1-4. [2]Royal Microscopy Society Infocus Review, 44 (2016),22. [3]Rev. Sci. Instr. 81 (2010), 113701. [4]Nanotechnology, 25 (2014), 145703. [5]Nanotechnology, 26 (2015), 13. [6]Appl. Phys. Lett. 105 (2014), 133112. [7]IEEE MTT March 2017, 1-9. [8]J. Appl. Phy. 116 (2014), 184301. [9]Nanotechnology 27 (2016), 135702. [10]ACS Nano, 10 (2016), 280.

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