DS 13: Thin Film Metrology for Electronics, Photonics, and Photovoltaics I

Time: Tuesday 10:30–12:00 Location: GER 38

Topical Talk DS 13.1 Tue 10:30 GER 38

Metrologie der Mikro- und Nanostrukturen mittels Rastersondenmikroskopie — •Teodor Gotszalk — ul. Janiszewskiego 11/17; Technische Universitatet zu Wroclaw; 50-372 Wroclaw

Der Fortschritt in der Nanotechnologie ist sowohl durch den Fortschritt in der Fabrikation der Mikro- und Nanostrukturen, wie auch durch die Entwicklung neuer Methoden zu ihrer Charakterisierung stimuliert. Von den neuen Charakterisierungsmethoden erwartet man vor allem hohe Empfindlichkeit, die in vielen Fällen die Beobachtung der quantenmechanischen Effekte in Nanometerskala ermöglichen soll. Im Gegenteil zu den Detektionsmethoden, die nur die qualitative Analyse erlauben, sollten die Messmethoden zusätzlich quantitativ die untersuchenden Phänome beschreiben. In diesem Vortrag werden die Beispiele zu den lokalen Messungen im Nanometerbereich von mechanischen, elektrischen und thermischen Eigenschaften der Metal-, Halbleiter- und biologischen Mikro- und Nanostrukturen mit Hilfe von piezoresistiven Silizium-Mikrosystemen vorgestellt. Die Messungen der Änderung der adsorbierter Masse, der Kraft und der Auslenkung mit der Auflösung von 10 ag, 1 pN und 0,01 nm Kraft, sind mit den hochauflösenden Kalibrierungsmethoden des verwendenten Messsystems verbunden. Diese Kalibrierungsmethoden, zu denen lichtfaseroptische Interferometrie, Untersuchungen des Rauschenverhaltens und der elektrischen Eigenschaften der Mikrosysteme mit Hilfe von modernen zählen, werden zusätzlich in diesem Vortrag vorgestellt.

DS 13.2 Tue 11:00 GER 38

Utilizing near-field and depolarization effects for tip-enhanced Raman spectroscopy on semiconductor nanostructures — •Peter Hermann[1], Zhijiat Chong[2], Michael Hecker[2], Phillip Olk[3], Martin Weisheit[2], Jochen Rinderknecht[2], Yvonne Ritz[2], Peter Kücher[1], and Lukas M. Eng[3] — [1]Fraunhofer-Center für Nanoelektronische Technologien, 01099 Dresden, Germany — [2]AMD Saxony LLC& Co KG, 01099 Dresden, Germany — [3]Institut für Angewandte Photophysik TU-Dresden, 01069 Dresden, Germany

Noble metal particles show very interesting and complex optical properties. One of the most striking phenomena encountered in these particles are electromagnetic resonances due to collective oscillations of the conduction band electrons. The excitation of plasmons leads to an increased light scattering and to an enhanced electromagnetic near-field in the vicinity of these particles. The depolarization of the incident light excites additional modes usually not observed in the far-field spectra. Therefore, beside the far-field polarization modes, the observed Raman enhancement contains also near-field contributions and additional modes excited by the scattered light. These contributions can be exploited to improve the optical resolution of conventional Raman spectroscopy thus allowing the characterization of stress in semiconductor structures on the nano-meter scale. For the evaluation of the achieved resolution, TERS scans across silicon-germanium line structures were performed.

DS 13.3 Tue 11:15 GER 38

Strain analysis of embedded SiGe structures by Raman spectroscopy and FEM modelling — •Marek Roelke[1], Michael Hecker[1], Yvonne Ritz[1], Ehrenfried Zschech[1], and Victor Vartanian[2] — [1]AMD Fab 36 LLC & Co. KG Dresden, Wilschdorfer Landstraße 101, D-01109 Dresden, Germany — [2]International Sematech Manufacturing Initiative (ISMI), 2706 Montopolis Drive, Austin, TX 78741-6499 University of Technology

Strained silicon below the transistor gate increases significantly the charge carrier mobility thus improving the performance of present leading-edge CMOS devices. For better understanding of structure-strain relationship at the nanoscale and for the development of improved device structures, measurement of the strain state has become essential. To enable the characterization of structures close to the production process the applied measurement technique has to be fast, with low preparation-induced impact onto the sample surface, and sensitive to local strain in silicon thin film structures. Raman spectroscopy meets these requirements very well. Thus it is used in the present investigation to analyze the strain distribution in and close to embedded SiGe structures in silicon wafers in conjunction with finite element (FE) analysis. After verifying our model by comparing experimental to theoretical outcomes we show how the stress state in both SiGe and Si regions is modified when scaling down the geometric dimensions. Analysis shows that the stress state in the strained Si-channel is very sensitive to the geometry of the surrounding materials as well as the proportion of Germanium in the SiGe regions.

DS 13.4 Tue 11:30 GER 38

Electromigration simulation for on-chip Cu interconnects — •Matthias Kraatz[1], Dieter Schmeisser[1], Ehrenfried Zschech[2], and Paul S. Ho[3] — [1]BTU Cottbus, Germany — [2]AMD Fab 36 Limited Liability Company & Co. KG — [3]University of Texas at Austin, USA

We are investigating the influence of copper microstructure on electromigration degradation effects and interconnect lifetimes using computer simulation. The simulation is carried out in three dimensions. For the copper microstructure, a Monte Carlo technique was used to model the Cu grain growth. Different diffusivities where applied to grain boundaries and top interface of the interconnect model according to the qualitative crystallographic orientation of adjacent grains. The grain boundary network and the top interface form the diffusion paths for the electromigration mass transport. Along the diffusion paths, the fluxes of vacancies where calculated including mechanical stress and electromigration driving forces using a finite difference method. Positive flux divergent sites of the FDM lattice are treated as void nucleation sites after a critical vacancy concentration is reached. The resistance increase due to void growth was calculated using a cellular automaton, masking current free regions as quasi voids and adding the resistance of the slices of the lattice normal to the electron flow direction in series. A parallel computing environment was used to generate large numbers of interconnect models in order to obtain a pool of data for statistical analysis of interconnect lifetimes. The results of this analysis will be shown

DS 13.5 Tue 11:45 GER 38

Metrology of nano-thin films by use of atomic force acoustic microscopy — •Malgorzata Kopycinska-Müller[1,2], Andrey Striegler[1,2], Arnd Hürrich[3], Bernd Köhler[1], Norbert Meyendorf[1], and Klaus-Jürgen Wolter[2] — [1]Fraunhofer IZFP-D, Dresden, Germany — [2]Technical University Dresden, Germany — [3]Fraunhofer IPMS, Dresden, Germany

We characterized using the atomic force acoustic microscopy (AFAM) technique the mechanical properties of nano-thin films of silicon oxide grown on silicon substrate. The films thicknesses ranged from 7 nm to 28 nm, as measured by ellipsometry method. The results of AFAM measurements showed that it is possible to determine the elastic properties of the film if its thickness is known. In addition, the preliminary analysis of the AFAM results indicated that it may be possible to use the AFAM technique to determine the thickness in a thin-film system if the elastic properties of the system components are known.

AFAM is a contact based method and as such provides information on the sample effective elastic properties from a certain volume that is compressed under an AFM tip. The information on the sample stiffness is obtained from the analysis of resonant vibrations of an AFM cantilever beam.