Gettering and Defect Engineering in Semiconductor Technology XIV

GADEST 2011, Loipersdorf, Austria

Abstract Booklet

Institut für Halbleiter- und Festkörperphysik
Johannes Kepler Universität Linz

XIVth INTERNATIONAL BIANNUAL MEETING
GETTERING AND DEFECT ENGINEERING IN SEMICONDUCTOR TECHNOLOGY
GADEST 2011

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Thursday September 29				
Defects at Interfaces				
Th1.1	9:00	Anton Bondarenko (invited)	V.A. Fok Institute of Physics, St. Petersburg State University, Russia	*Dislocation structure, electrical and luminescent properties of hydrophilically bonded silicon wafer interface*
Th1.2	9:40	Vladimir Vdovin	St.Petersburg State University, V.A. Fok Institute of Physics, Russia	*Mechanisms of Dislocation Network Formation in Si(001) Hydrophilic Bonded Wafers*
Th1.3	10:00	Maria Luisa Polignano	Micron, Italy	*Analysis of contaminated oxide-silicon interfaces*
Th1.4	10:20	Ma Xiangyang	State Key Laboratory of Silicon Materials, Zhejiang University, China	*Nitrogen Enhanced Oxygen Precipitation in Czochralski Silicon Wafers Coated with Silicon Nitride Films*
	10:40	*Coffee Break*		
SiGe				
Th2.1	11:00	Hans von Känel (invited)	ETH Zurich and Politecnico di Milano	*Heteroepitaxial integration on Si by substrate patterning*
Th2.2	11:40	Martyna Grydlik	Institute of Semiconductor and Solid State Physics, Johannes Kepler University Linz, Austria	*Giant Ge surface diffusion length and stable island sizes during the nucleation of SiGe islands on pattered and planar Si(001) substrates*
Th2.3	12:00	Nikolay V. Abrosimov	Ioffe Physicotechnical Institute, Russian Academy of Sciences, Russia	*Electron Mobility in Moderately Doped Si1-xGex*
	12.20	*Lunch Break*		
Si/SiO$_2$ Interface				
Th3.1	14:00	Tibor Grasser (invited)	Institute for Microelectronics, TU Vienna	*Bistable Defects as the Cause for NBTI and RTN*
Th3.2	14:40	Daniel Kropman	Tallinn University of Technology, Estonia	*Interaction of point defects with impurities in the Si-SiO2 system and its properties modification*
	15:00	*Coffee Break*		
Defect Characterization III				
Th4.1	15:40	Andre Stesmans (invited)	University of Leuven, Belgium	*Comparative analysis of intrinsic point defects at thermal Si and GexSi1-x/oxide interfaces: ESR diagnosis and electrical activity*
Th4.2	16:20	Roman Kozlowski	Institute of Electronic Materials Technology, Poland	*Annealing Induced Evolution of Defect Centers in Epitaxial Si Irradiated with High Proton Fluences*
Th4.3	16:40	Yana Gurimskaya	Institut d'Électronique du Solide et des Systèmes, InESS (Université de Strasbourg and CNRS), France	*Spectroscopic studies of Iron and Chromium in Germanium*

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Bistable Defects as the Cause for NBTI and RTN

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Keywords: noise, negative bias temperature instability, charge trapping, defects

Abstract. Over the last few decades convincing evidence has been collected demonstrating that the oxide reliability is most seriously affected by hole trapping into defects. Recently, valuable information has been delivered by a newly developed measurement technique called time-dependent defect spectroscopy (TDDS), which allows to analyze the behavior of single defects. It indicates the existence of additional metastable defect configurations which are necessary to explain various features seen in TDDS. In this study, it will be shown that these bistable defects may also be the origin of noise phenomena, such as temporary and anomalous random telegraph noise observed in MOSFETs.

Introduction

As MOSFETs have been scaled into the nanometer regime, discrete fluctuations in the terminal currents have become increasingly important. This phenomenon is known as random telegraph noise (RTN) and has been intensively investigated over the years [1, 2, 3, 4, 5]. According to the current understanding, the origin of RTN lies in defects which are capable of exchanging charge carriers with the substrate via quantum mechanical tunneling. Even though this general picture is commonly accepted, the physical details of the underlying mechanism are still under debate.

Independently of the progress in this field, major advances have been made regarding the negative bias temperature instability (NBTI) [6, 7, 8, 9]. While in the past chemical reactions at the semiconductor-dielectric interface controlled by the diffusion of hydrogen have been made responsible for this phenomenon, the latest findings indicate that the device degradation is dominated by charge trapping into defects. It has therefore been suggested that the physical cause of RTN and NBTI can be ascribed to the same trapping mechanism. This speculation has been supported by a number of similarities in the defect properties [6, 10].

Recent Experimental Findings in NBTI research

Until lately, NBTI has primarily been studied by simply monitoring the degradation and recovery of large-area devices. Hence, the data contains the collective behavior of thousands of defects which obscures the details of the charge trapping process. However, the reduction in device dimensions has come to a point where single charging or discharging events appear as steps in the recorded recovery traces. Just like in RTN, the difficulty to assign a single trapping event to a certain defect, has hampered the analysis of experimental data [11]. Recently, a new measurement technique, called time-dependent defect spectroscopy (TDDS), has been suggested to overcome this problem [12, 13]. It exploits the fact that a trapped charge impacts the current percolation path of the drain current and thus the threshold voltage differently depending on where it is located on the gate area. As a consequence, the charging of a certain defect always results in similar step heights. This fact can thus be used to relate a certain emission event to the corresponding defect. This method offers two substantial advantages:

- Provided that either the capture or the emission times or the step height of two defects differ, TDDS can capture a multitude of traps in a single measurement run. This fact immensely increases the versatility of the method, compared to the conventional RTN analysis.