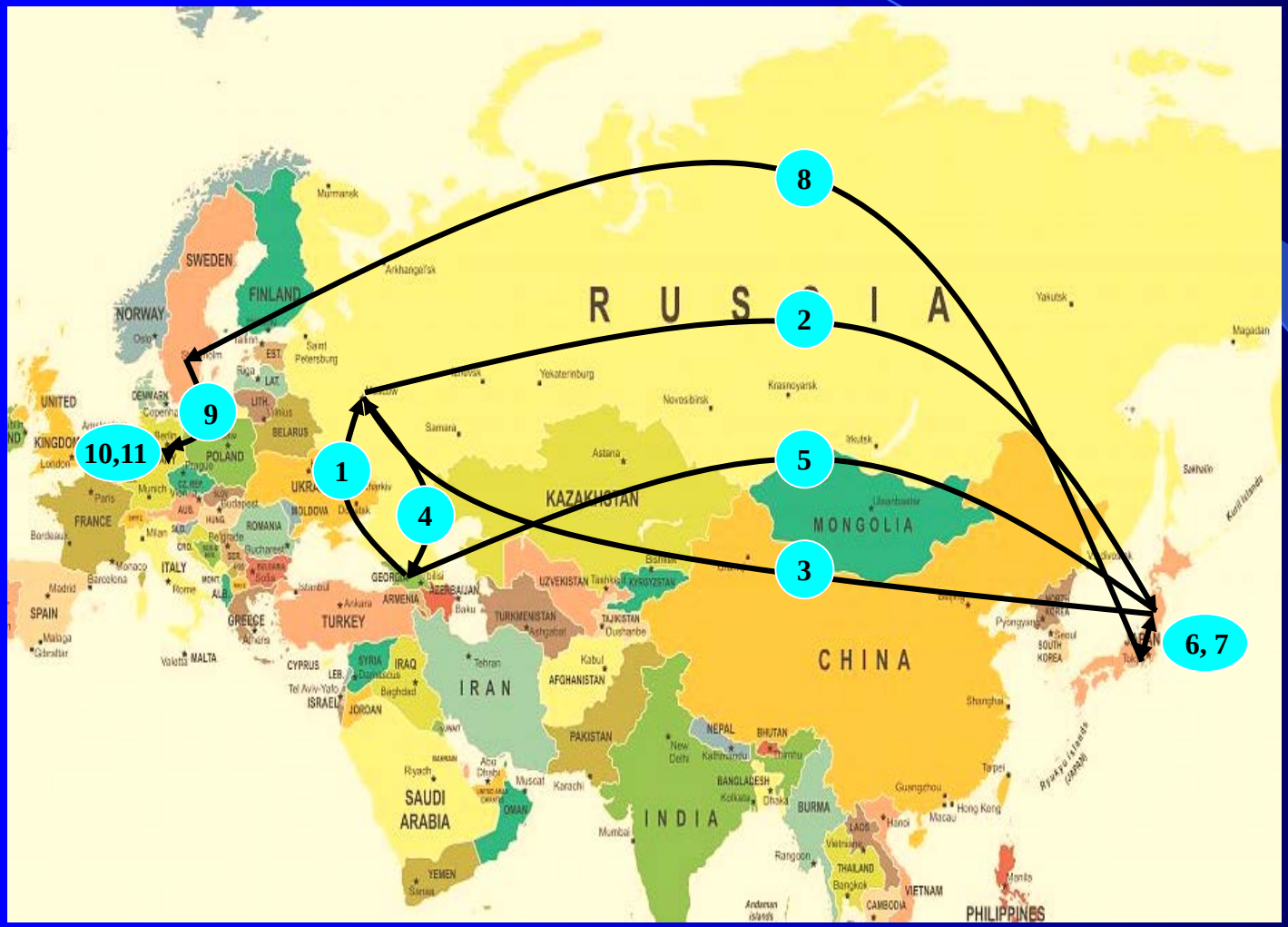
Defects, structures, methods

Teimuraz Mchedlidze

თეიმურაზ მჭედლიძე, Teimouraz Mtchedlidze,
T. McHedlidze, Теймураз Мчедлидзе,
泰邑都, テイムラズ ムチェドウリゼ, T. Mchelidze,
Muchedo, Emu. T., Malush, Serioja, Tai, Tei, Timka,
Teimuraz Ramaz M., T.R.M., Feimouraz, Tei Mtschedlidze

www.teimuraz.net

Outline: locations



Tbilisi, Georgia
①
Chernogolovka, Russia
②
Sendai, Japan
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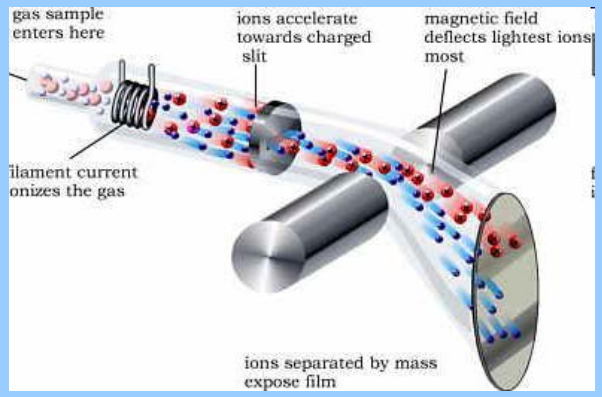
Chernogolovka, Russia
④
Tbilisi, Georgia
⑤
Sendai, Japan
⑥
Hiratsuka, Japan
⑦
Sendai, Japan
⑧
Linköping, Sweden
⑨
Cottbus, Germany
⑩
Dresden, Germany
⑪
Freiberg, Germany

Outline: studies, methods, objects

Where	How	What
Tbilisi, TSU	Carbon dating, Mass-spectrometry	Laser source MS
Chernogolovka, ISSP	EPR, EDMR, EDSR, DLTS, PL	Si, HTC SC, defects
Sendai, IMR	EPR, EDSR, DLTS, FTIR	Si defects
Chernogolovka, ISSP	HRTEM, DLTS, PL	Si, Ge, defects
Sendai, IMR	ESR, HRTEM, EDSR, FTIR	Si-Ge, grinding
Hiratsuka, Komatsu EM	HRTEM, TDDB, TZDB, DLTS, EDMR	SIMOX, COP, defects
Sendai, IMR	ESR, FTIR, DLTS	Si, Ge
Linköping, LIU	ODMR, EDMR, EL	InGaAs, Ga(Al)NAs, …
Cottbus, JointLab	PL, Raman, EBIC, DLTS	PV, Nano-tec, LID, Si
Dresden, TUD IAP	EL, DLTS, IRPC, Electrical methods	PV, HKMG FET
Freiberg, TUBAF IAP	Electrical methods, …	HKMG FET…

Main subject: Laser and spark-source mass-spectrometry

Affiliation: Tbilisi State University & Institute for Analytical Chemistry, Moscow
Country: USSR; **Period**: 1978-84
Positions: Ms. student, research-engineer
Publications: 5



International Journal of Mass Spectrometry and Ion Processes, 63 (1985) 1–15 1
Elsevier Science Publishers B.V., Amsterdam – Printed in The Netherlands

FACTORS AFFECTING THE RELATIVE SENSITIVITY COEFFICIENTS IN SPARK AND LASER PLASMA SOURCE MASS SPECTROMETRY

G.I. RAMENDIK, O.I. KRYUCHKOVA, D.A. TYURIN
V.I. Vernadsky Institute of Geochemistry and Analytical Chemistry, Academy of Sciences of the U.S.S.R., B-334 Moscow 117975 GSP-1 (U.S.S.R.)

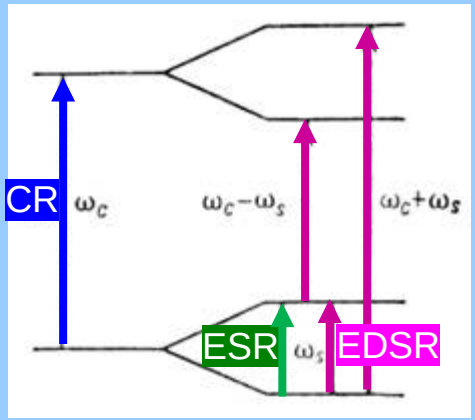
T.R. MCHEDLIDZE and M.SH. KAVILADZE
Department of Physics, Tbilisi State University, Tbilisi (U.S.S.R.)

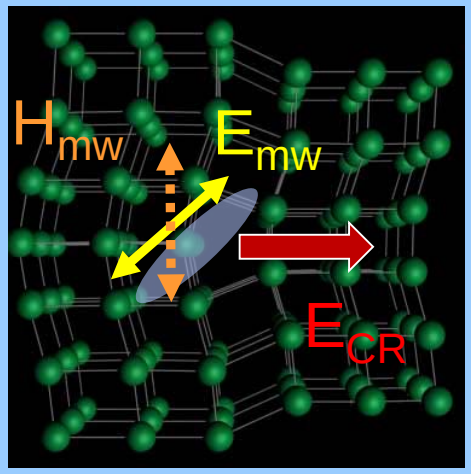
(First received 10 November 1983; in final form 9 July 1984)

- How much energy should be invested in the process of ion formation?
- What is most important: substrate or impurities?
- Double excitation, for evaporation and for ionization.
- Spark, laser or ions?

Main subject: Electric-dipole spin resonance on dislocations in silicon

Affiliation: Institute of Solid State Physics, USSR Science academy, Chernogolovka
Country: USSR; **Period**: 1984-94
Positions: PhD student, researcher
Publications: 17 manuscripts





Combined electron resonance in a one-dimensional dislocation band

V. V. Kveder, T. R. Mchedlidze, Yu. A. Osip'yan, and A. I. Shalynin

Institute of Solid State Physics, Academy of Sciences of the USSR
(Submitted 13 March 1987)
Zh. Eksp. Teor. Fiz. 93, 1470–1479 (October 1987)

The intensity and width of the combined electron resonance line for dislocations in silicon are investigated as functions of temperature, microwave electric field, and illumination. The resonance intensity grows as $T^{-2.4}$ with decreasing temperature; this indicates that the electron mobility increases, and hence that band conduction rather than hopping along dislocations is the primary conduction mechanism. The energy of the dislocation band is found, and the saturation and width of the line are discussed.

Relationship between a combined resonance in plastically deformed *n*-type silicon with a dislocation structure

V. V. Kveder, T. R. Mchedlidze, Yu. A. Osip'yan, and A. I. Shalynin

Institute of Solid-State Physics, Academy of Sciences of the USSR, Chernogolovka, Moscow Province
(Submitted December 15, 1989)
Fiz. Tverd. Tela (Leningrad) 32, 2224–2229 (August 1990)

The dependences of a combined resonance signal in plastically deformed *n*-type single-crystal silicon on the conditions of deformation and subsequent annealing were determined. Some hypotheses are proposed regarding the specific types of defects responsible for the signal. Influence of electrically neutral impurities on the combined resonance spectrum was observed. The results should make it possible to study the characteristics of the structure of deformed silicon by the combined resonance method.

- SO interaction in absence of inversion center.
- Straight dislocations.
- 7-8 orders of ESR strength.

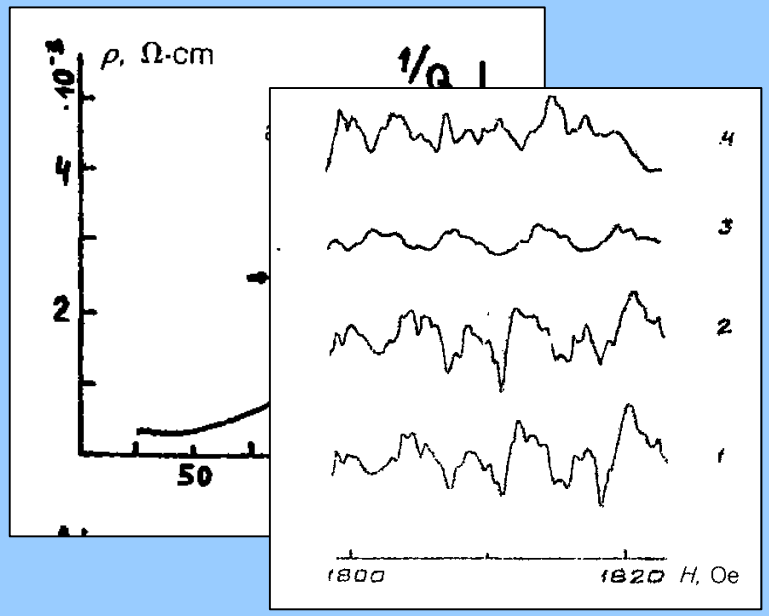
Extra subjects: High Tc superconductivity Defect states on dislocations

Characteristics of microwave losses in a superconducting ceramic subjected to a magnetic field

V. V. Kveder, T. R. Mchedlidze, Yu. A. Osip'yan, and A. I. Shalynin
Institute of Solid-State Physics, Academy of Sciences of the USSR, Chernogolovka, Moscow Province

Pis'ma Zh. Eksp. Teor. Fiz. **46**, Prilozh., 176–179 (1987)

An oscillatory dependence of the microwave losses R in a superconducting ceramic based on YBaCuO on a static magnetic field was attributed to quantized penetration of the magnetic flux into the superconducting network. An analysis of the Fourier transform of $R(H_0)$ made it possible to estimate the parameters of this network.



phys. stat. sol. (a) **146**, 745 (1994)

Subject classification: 71.55; 72.20; 78.55; S5.11

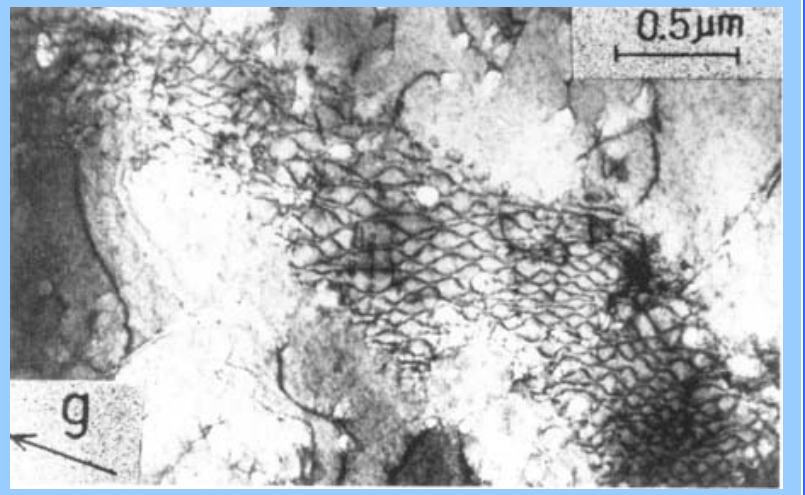
Institute of Solid State Physics, Russian Academy of Sciences, Chernogolovka[1]) *(a) and Institute of Physics, Tbilisi State University*[2]) *(b)*

Defect States in Si Containing Dislocation Nets

By

S. A. SHEVCHENKO (a), YU. A. OSSIPYAN (a), T. R. MCHEDLIDZE (b), E. A. STEINMAN (a), and R. A. BATTO (a)

Dc conductivity, Hall effect, and photoluminescence spectra are studied in heavily deformed samples containing a connected system of dislocation cell walls. The conclusion is made that, in deformed Si, empty and filled electron states 0.3 to 0.4 eV from the upper and lower edges of the band gap, respectively, are related to dislocation defects (kinks, jogs, constrictions, etc.). As a result, the Fermi level is pinned in the vicinity of localized states near the middle of the band gap. Therefore, dc conductivity along the dislocation system is absent.



Main subject: Electric-dipole spin resonance on rod-like defects

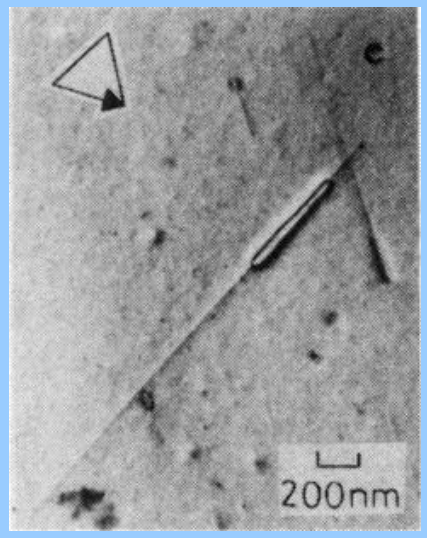
Affiliation: Institute for Materials Research
Country: Japan; **Period**: 1991-92, 94-95
Positions: JSPS fellow, research associate
Publications: 7 manuscripts

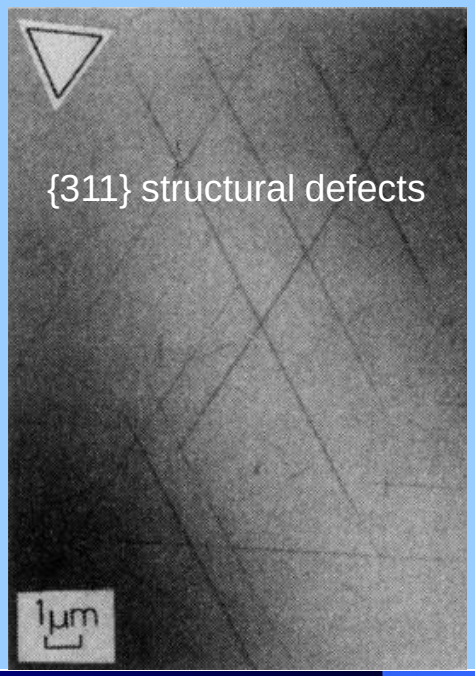
PHYSICAL REVIEW B VOLUME 50, NUMBER 3 15 JULY 1994-I

Electric-dipole spin-resonance study on extended defects in Czochralski-grown silicon developed by thermal treatment

T. R. Mchedlidze,* V. V. Kveder,* J. Jablonski,† and K. Sumino
Institute for Material Research, Tohoku University, Sendai 980, Japan
(Received 22 November 1993)

A series of electric-dipole spin-resonance (EDSR) lines, termed Si-*SC*1 lines, are found to develop in Czochralski-grown Si crystals due to annealing at 650 °C. Some of these lines are very close to Si-2*K* and Si-3*K* reported in a previous work. The experimental data are self-consistently explained by use of a model that shows that the EDSR signals are caused by additional electrons trapped by long quasi-one-dimensional defects lying along the ⟨110⟩ directions. The localization length of the trapped electrons is determined to be of the order of 100 nm and their mobility to be rather high along the defects, suggesting that a quasi-one-dimensional energy band is associated with the straight part of the defect. Si-*SC*1 centers are attributed to the so-called rodlike defects that are developed in the Czochralski-grown Si crystals due to the above heat treatment.





- Identification of defects responsible for EDSR signal
- Relation between EDSR intensity and MW conductivity
- Relation between EDSR line-shape and RLD structure

Extra subjects: Growth & properties of SiGe crystals Influence of Fe on oxygen precipitation

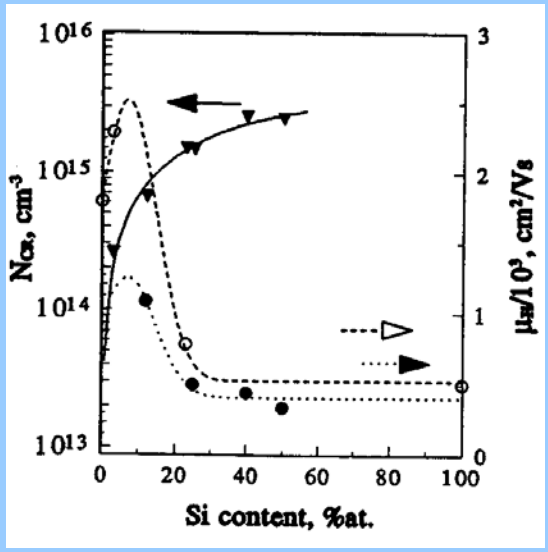
Materials Science Forum Vols. 196-201 (1995) pp. 353-358

ELECTRICAL TRANSPORT IN Si_XGe_{1-X} BULK ALLOYS

T.R.MCHEDLIDZE*, I.YONENAGA, A.MATSUI AND K.SUMINO
Institute for Materials Research, Tohoku University, Sendai 980-77, JAPAN

Keywords: SiGe alloys, carrier transport in polycrystals

Abstract. The carrier transport in monocrystalline Si_XGe_{1-X} bulk alloys with X=0.03 and X=0.23 and in polycrystalline alloys with $0.12 \le X \le 0.5$ grown by the Czochralski method was investigated by means of Hall effect and resistivity measurements. The defect arrangement in the samples was observed by preferential etching. With no impurity deliberately added grown alloys reveal acceptor properties with carrier concentration increasing from $3\times10^{14}cm^{-3}$ for X=0.03 to $1.35\times10^{15}cm^{-3}$ for X=0.5. In monocrystalline samples the acceptor level is located near to E_V+0.14eV. Hall mobility in the monocrystalline samples is affected by alloy scattering even at high temperatures. Grain boundaries strongly lower Hall mobility in the polycrystalline samples.



Materials Science Forum Vols. 196-201 (1995) pp. 1859-1864

OXYGEN PRECIPITATION IN CZ SILICON CRYSTALS CONTAMINATED WITH IRON

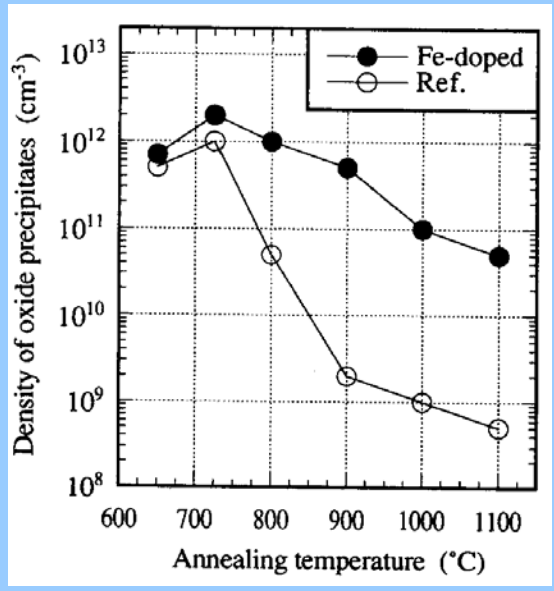
J. JABLONSKI [1], B. SHEN [2]*, T. R. MCHEDLIDZE [2]**, M. IMAI [1] AND K. SUMINO [2]

[1] Komatsu Electronic Metals Co., Ltd., 2612, Shinomiya, Hiratsuka, Kanagawa 254, JAPAN

[2] Institute for Materials Research, Tohoku University, Sendai 980, JAPAN

Keywords: CZ silicon, oxygen precipitation, iron impurity

Abstract. Effects of iron impurity on precipitation process of oxygen and development of defects related to oxygen precipitation in CZ silicon have been investigated by means of transmission electron microscopy, Fourier transform infrared absorption, electron paramagnetic resonance, electric-dipole spin resonance and resistivity measurements. Specimens were intentionally contaminated with iron at different levels between 10^{14} and 10^{16} atoms/cm^3. The formation of oxide precipitates was significantly enhanced by Fe impurity, especially at temperatures higher than about 800°C. Also the generation of new donors was enhanced in Fe-doped samples whereas the growth of rod-like defects was suppressed. The formation of thermal donors was not apparently affected by iron. Observed phenomena are interpreted as originating from the strong enhancement effect of Fe impurity on the nucleation process of oxide precipitates in CZ silicon crystals.



Extra subjects: Growth & properties of SiGe crystals Influence of Fe on oxygen precipitation

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T.R.MCH
Institut

Keywords: SiGe al

Abstract. The carr
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boundaries strongly

Jpn. J. Appl. Phys. Vol. 35 (1996) pp. 652–655
Part 1, No. 2A, February 1996

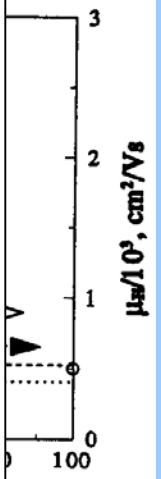
Hall Effect in Anisotropic Si_xGe_{1-x} Polycrystals

Teimouraz R. MCHEDLIDZE and Ichiro YONENAGA[1]
Komatsu Electronic Metals Co., 2612, Sinomiya, Hiratsuka 254, Japan
[1] *Institute for Materials Research, Tohoku University Sendai 980, Japan*

(Received August 24, 1995; accepted for publication October 6, 1995)

We studied carrier transport in Si_xGe_{1-x} polycrystalline bulk alloys grown by the Czochralski method. The grains in the alloys are elongated in the growth direction due to the supercooling effect. At a high concentration of grains, the anisotropy of their shape leads to an observable anisotropy in the electrical properties of the alloys. The "two-phase geometrical model" was applied to estimate the transport properties of the grains and grain boundary materials from the Hall effect measurements in different directions of the alloys. The results show that in the SiGe polycrystalline alloy, conductive grains are surrounded by high-resistivity barriers. The height of the barriers was calculated to be 0.38 eV and "electrical" thickness 3×10^{-5} cm.

KEYWORDS: SiGe, polycrystals, carrier transport, Hall effect



Materials Science Forum Vols. 196-201 (1995) pp. 1859-1864
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OXYGEN PRECIPITATION IN CZ SILICON CRYSTALS CONTAMINATED WITH IRON

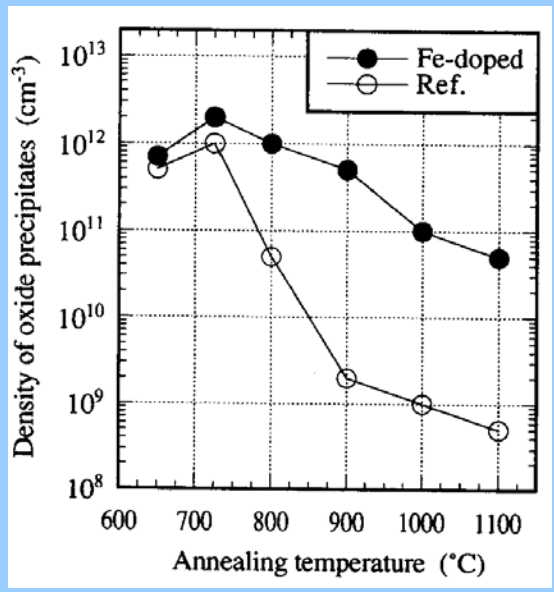
J. JABLONSKI [1], B. SHEN [2]*, T. R. MCHEDLIDZE [2]**, M. IMAI [1] AND K. SUMINO [2]

[1] Komatsu Electronic Metals Co., Ltd., 2612, Shinomiya, Hiratsuka, Kanagawa 254, JAPAN

[2] Institute for Materials Research, Tohoku University, Sendai 980, JAPAN

Keywords: CZ silicon, oxygen precipitation, iron impurity

Abstract. Effects of iron impurity on precipitation process of oxygen and development of defects related to oxygen precipitation in CZ silicon have been investigated by means of transmission electron microscopy, Fourier transform infrared absorption, electron paramagnetic resonance, electric-dipole spin resonance and resistivity measurements. Specimens were intentionally contaminated with iron at different levels between 10^{14} and 10^{16} atoms/cm^3. The formation of oxide precipitates was significantly enhanced by Fe impurity, especially at temperatures higher than about 800°C. Also the generation of new donors was enhanced in Fe-doped samples whereas the growth of rod-like defects was suppressed. The formation of thermal donors was not apparently affected by iron. Observed phenomena are interpreted as originating from the strong enhancement effect of Fe impurity on the nucleation process of oxide precipitates in CZ silicon crystals.



Extra subjects: Defects in Si polished in ductile mode

Materials Science Forum Vols. 196-201 (1995) pp. 1841-1846

SUBSURFACE DAMAGE IN SINGLE DIAMOND TOOL MACHINED SI WAFERS

T.R.MCHEDLIDZE*, I.YONENAGA AND O
Institute for Materials Research, Tohoku U , JAPAN

One of citation leaders

Keywords: Surface damage, Du

Abstract. The su s in single diamond tool machined Si wafers were investigated by means of cross-sec and plan view TEM, cross-sectional high-resolution TEM and preferential etching of the machined surface. The subsurface of machined samples consists of thin amorphous layer, layer with dislocations and shallow cracks, and separate deep, median and lateral cracks. As the results of the investigations have shown, the most promising (for less severe damage) is the single directional grinding with possibly small penetration depth of the diamond tool.

- Damage (cracks & dislo-cations) density depends on lattice directions in the crystal: single directional grinding?
- Thin (5-20 nm) a-Si layer is formed at top.
- Compressive stress in cracked layer is ~2 Gpa.

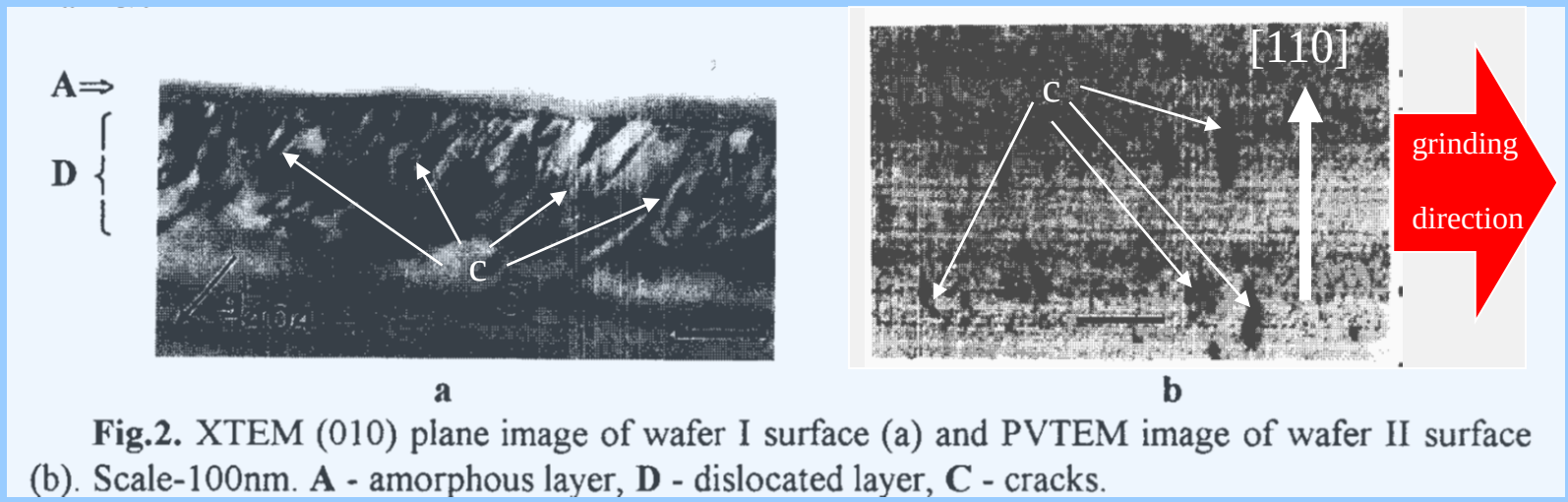


Fig.2. XTEM (010) plane image of wafer I surface (a) and PVTEM image of wafer II surface (b). Scale-100nm. **A** - amorphous layer, **D** - dislocated layer, **C** - cracks.

Subject: Defects in Cz and FZ-Si

Affiliation: Komatsu Electronic Metals
Country: Japan; **Period**: 1995-2000
Positions: Device group manager
Publications: 11 manuscripts

The Direct Observation of Grown-in Laser Scattering Tomography Defects in Czochralski Silicon

Masashi Nishimura, Shiroh Yoshino, Hi... hi Shimura, Teimouraz Mch... one
Komatsu Electronic Met... omiya, Hiratsuka, Kanagawa 254, Japan

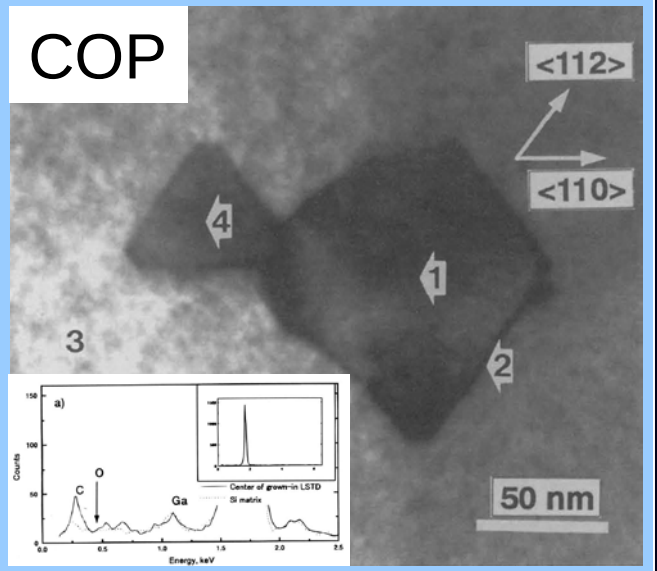
2nd on citations: 73

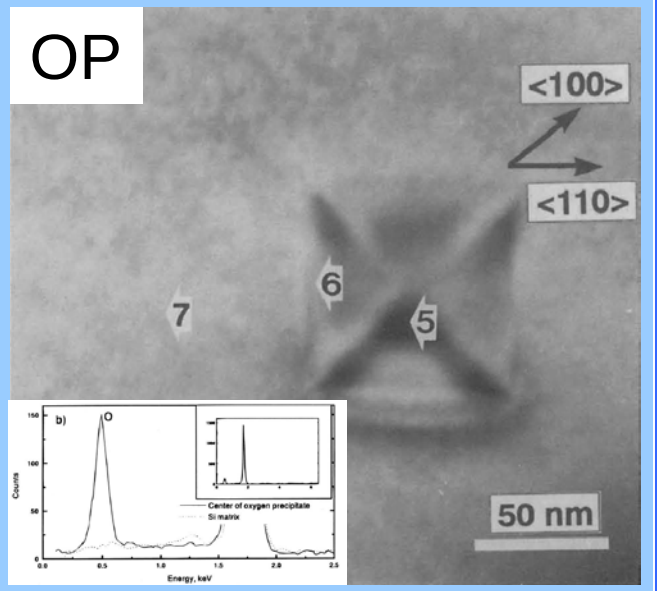
ABSTRACT

For the first time as-grown laser scattering tomography defects (LSTD), twins, was observed directly in the Si wafer with transmission electron microscopy (TEM). The shape of the grown-in LSTDs, estimated from the TEM images, were octahedral and tetrahedral, with side-walls lying in the {111} plane. The size of grown-in LSTDs are approximately 100 nm. The oxygen concentration inside the grown-in LSTD was close to the detection limit of TEM-EDX

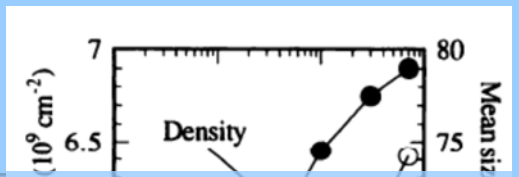
J. Electrochem. Soc., 1996, Vol. 143, L244

- Comparison of HR TEM and EDX analyses results.
- Looks like COP inside is empty (Ga comes from preparation)! Agglomeration of vacancies.
- Shape of COP is octahedron with <111> sidewalls. Size is about 100nm.

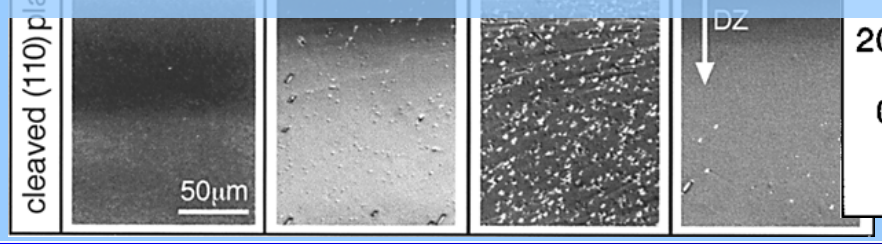


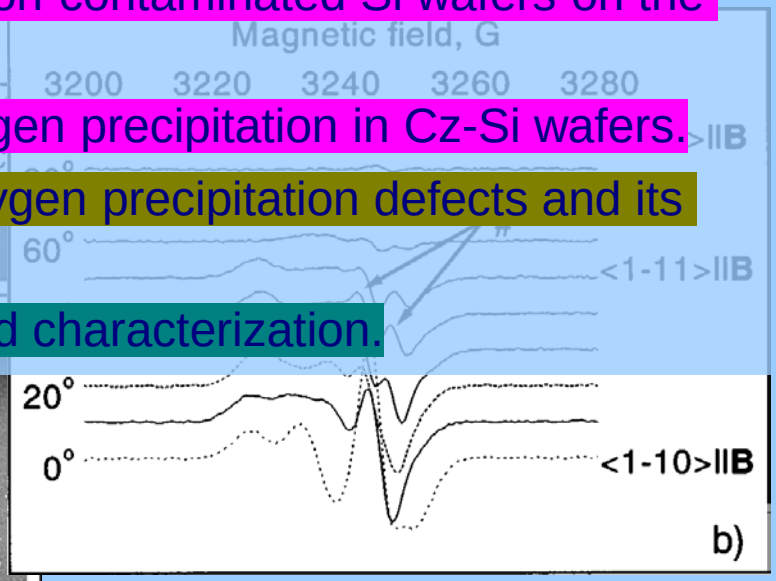


Subject: Defects in Cz and FZ-Si



- Effect of oxidizing ambient on the buried oxide synthesis in low-dose SIMOX.
- Silicon incorporation in a shallow donor center in hydrogenated Czochralski-grown Si crystals: an EPR study
- EPR study of hydrogen-related radiation-induced shallow donors in silicon.
- Electrically detected magnetic resonance signal from iron contaminated Cz-Si crystal.
- Dependence of EDMR signal shape from iron-contaminated Si wafers on the thermal treatment of the samples.
- Electrical activity of defects induced by oxygen precipitation in Cz-Si wafers.
- N^+P-junction leakage current caused by oxygen precipitation defects and its temperature dependence.
- Si wafer polishing damage classification and characterization.





Subject: Defects in Cz and FZ-Si

Gate Oxide Integrity Evaluation using Non-ideal Metal-Oxide-Silicon Capacitor Structure

Teimuraz Mchedlidze

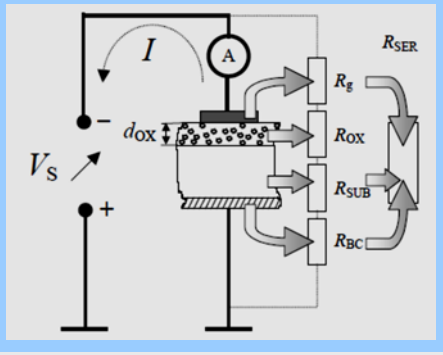
Institute for Materials Research, Tohoku University, 8577, Japan

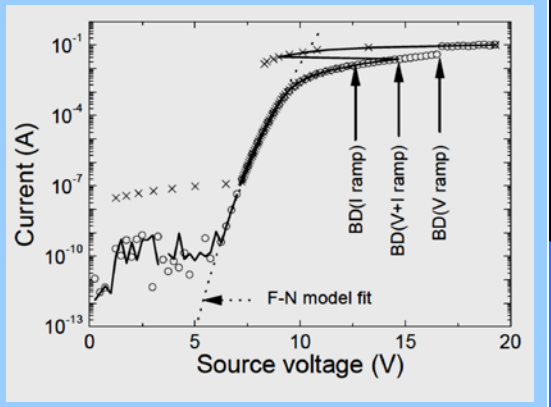
Keywords: Gate Oxide Integrity, Silicon ... Evaluation

Abstract. The factors det... accuracy of gate oxide integrity (GOI) evaluation using non-ideal metal-oxide-s... capacitor (MOSCAP) structures are investigated. For the MOSCAP s... a polycrystalline silicon gate fabricated on the top of an oxidized Si wafer ... stances of the gate, substrate material and wafer backside contact can influence ... uation accuracy. The evaluation errors are especially strong in the case of thin and h... quality oxide films, where the intense electric fields are used during the measurements. Finally we propose modifications to the measurement and data evaluation procedures, which can minimize the GOI evaluation errors, improve accuracy and sensitivity.

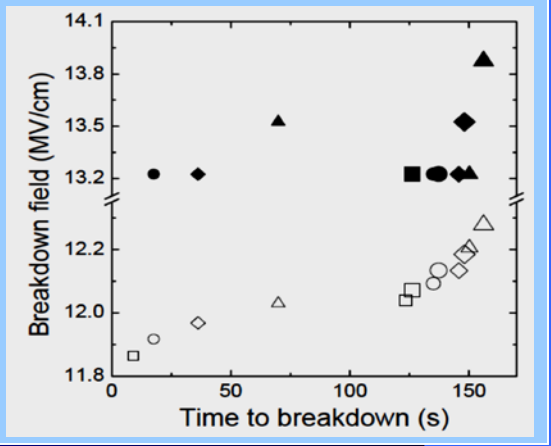
Solid State Phenomena 2001, Vol. 82-84, pp. 735-742

RG champion : > 455 reads in last 5 years!



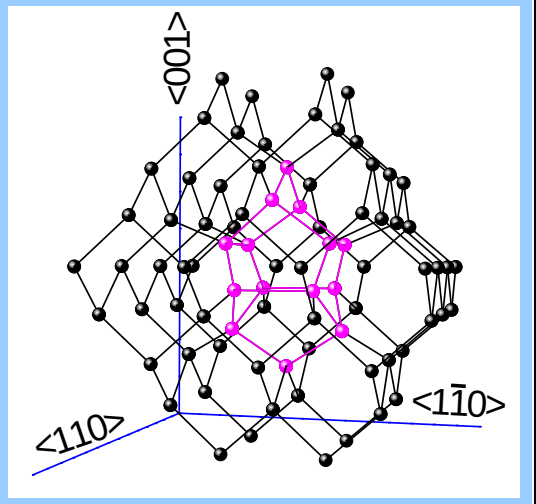


- Increase in the number and the proper arrangement of measuring tips contacting poly-Si gate.
- Combination of voltage ramp for low electric field region and current ramp for strong electric field region.
- Calculation of actual breakdown field, using values of current and oxide resistance at the breakdown moment.



Subject: Defects in Cz and FZ-Si

Affiliation: Institute for Materials Research
Country: Japan; **Period**: 2000-04
Positions: Research associate
Publications: 22 manuscripts



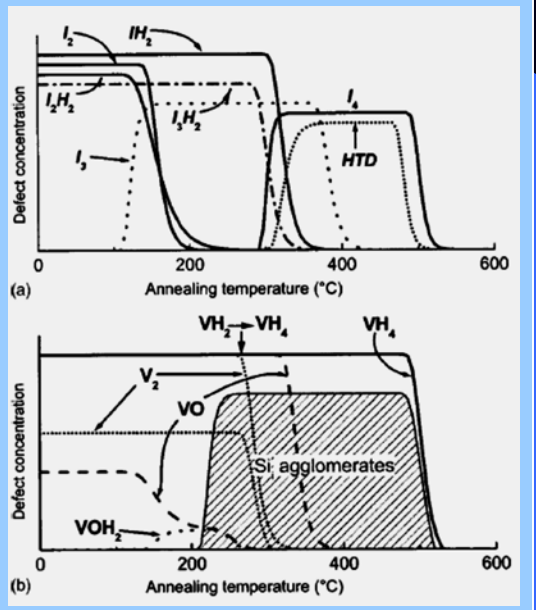
PHYSICAL REVIEW B 70, 205203 (2004)

Properties and formation mechanism of tetrainterstitial agglomerates in hydrogen-doped silicon

Teimuraz Mchedlidze* and Masashi Suesawa
Institute for Materials Research, Tohoku University, Sendai 980-8577, Japan
(Received 23 January 2004; revised manuscript received 14 June 2004; published 4 November 2004)

For the tetrainterstitial agglomerate (I_4), four additional silicon (Si) atoms are incorporated in an ordinary unit cell of Si lattice in such a manner that all atoms are four-coordinated and angles between bonds are not disturbed significantly. Microstructure, electrical properties, and formation mechanism of I_4 in Si were inferred from the investigation of associated electron spin resonance (ESR) spectra in various samples under various experimental conditions. It was found that the B3 ESR spectrum is related to a positive charge state of I_4 and the NL51 spectrum is related to the excitonic state of the neutral defect. In Si samples predoped with hydrogen, formation of tetrainterstitial agglomerates after electron-irradiation and annealing is associated with various reactions of hydrogen with intrinsic defects.

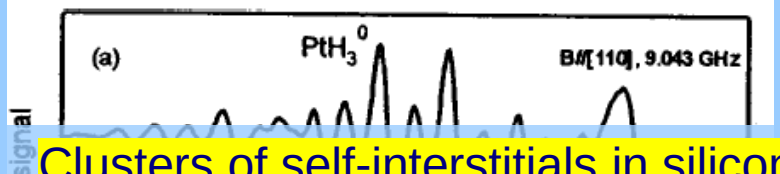
DOI: 10.1103/PhysRevB.70.205203 PACS number(s): 61.72.−y, 61.46.+w, 61.80.Fe, 71.55.Cn

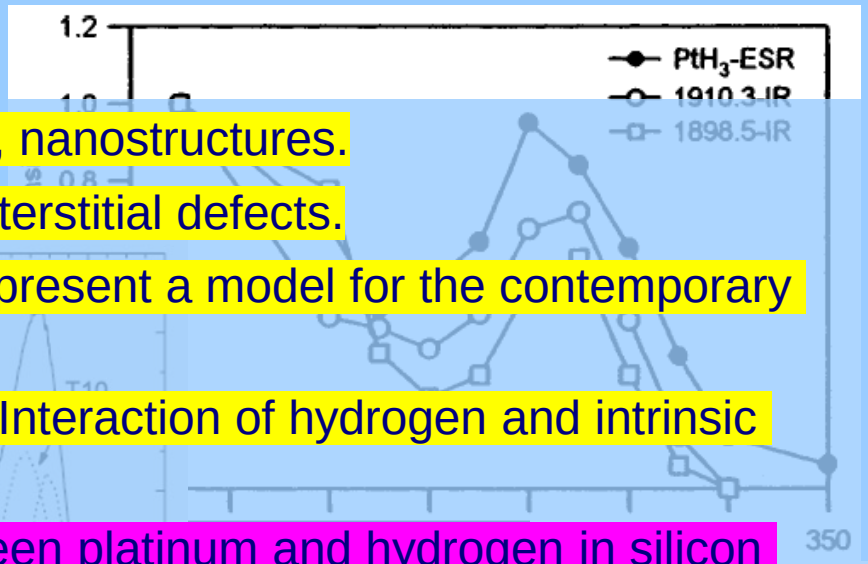


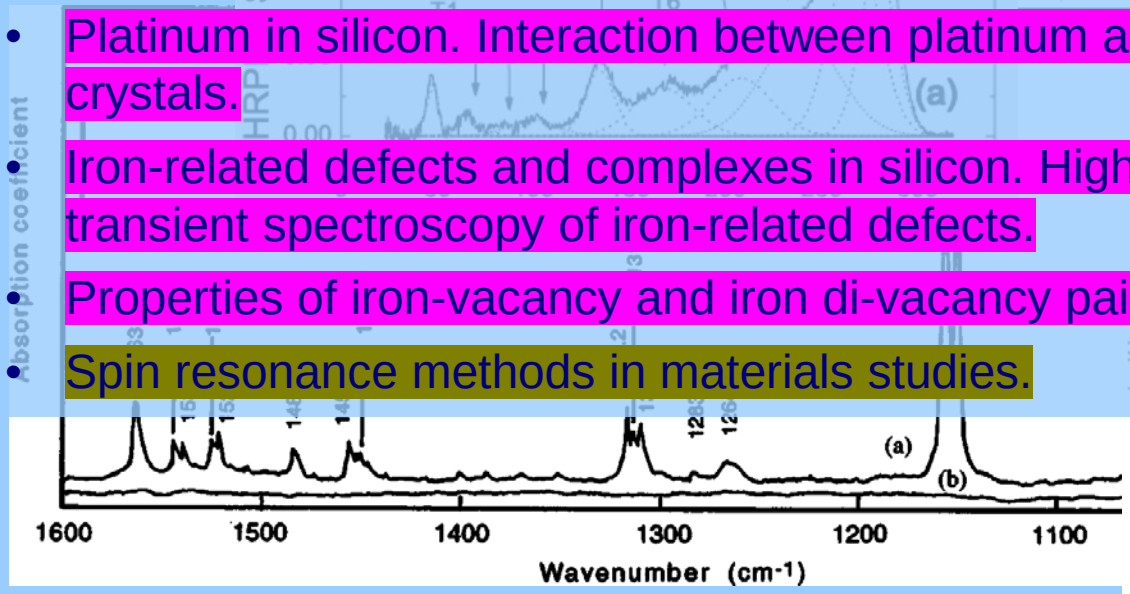
- B3 & NL51 originate from charge states of I4.
- I4 parameters determined: size of exciton, ratio of lifetimes in singlet and triplet states, energy level…
- I4 formation mechanism proposed.

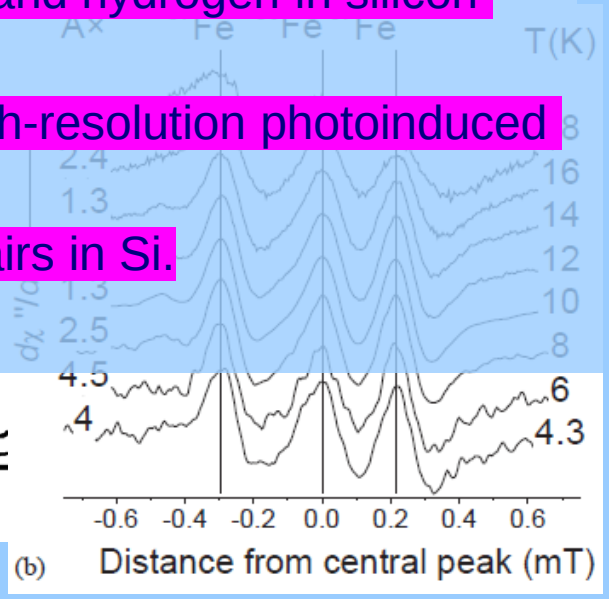
Subject: Defects in Cz and FZ-Si

- Clusters of self-interstitials in silicon, nanostructures.
- Properties and interaction of tetra-interstitial defects.
- Defects in silicon samples, which represent a model for the contemporary "device area" of silicon wafers.
- Hydrogen-related defects in silicon. Interaction of hydrogen and intrinsic defects and defect clysters.
- Platinum in silicon. Interaction between platinum and hydrogen in silicon crystals.
- Iron-related defects and complexes in silicon. High-resolution photoinduced transient spectroscopy of iron-related defects.
- Properties of iron-vacancy and iron di-vacancy pairs in Si.
- Spin resonance methods in materials studies.









Subject: Defects in Cz and FZ-Si

INSTITUTE OF PHYSICS PUBLISHING — JOURNAL OF PHYSICS: CONDENSED MATTER

J. Phys.: Condens. Matter 16 (2004) L79–L84 — PII: S0953-8984(04)73996-X

LETTER TO THE EDITOR

An iron–phosphorus pair in silicon

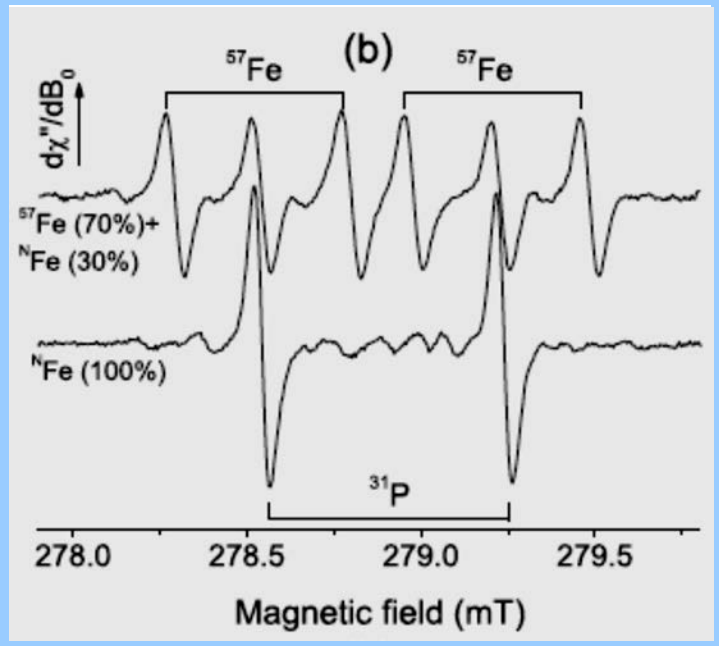
Teimuraz Mchedlidze and Masashi Suezawa

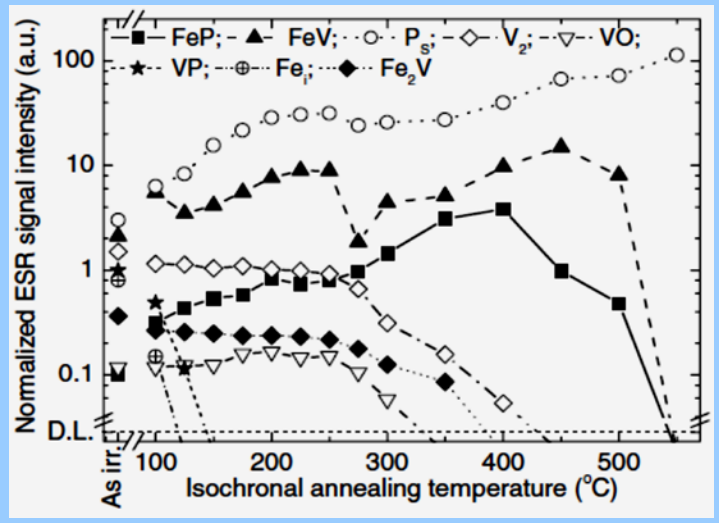
Institute for Materials Research, Tohoku University, Sendai 980-8577, Japan

Received 6 January 2004
Published 13 February 2004
Online at stacks.iop.org/JPhysCM/16/L79 (DOI: 10.1088/0953-8984/16/8/L02)

Abstract

For n-type (phosphorus-doped) floating-zone grown silicon samples, a hitherto unreported ESR signal was detected after the samples were doped with iron and irradiated with electrons. Analysis of the hyperfine structure and the angular dependence of the resonance peak positions of the spectrum, labelled TU6, indicated that the signal originates from a defect complex of monoclinic-I symmetry containing single phosphorus and single iron atoms. The spectrum can be described in terms of a paramagnetic system with $S = 1/2$ and g values greatly deviating from that of a free electron, as well as spin $S = 3/2$ and $g \approx 2$. The spin $S = 3/2$ may correspond to a positively charged iron atom ($3d^7$ state) and, thus, to a doubly positive charge state of a TU6 related complex. The fact that the TU6 signal was detected only under strong external illumination for n-type samples also supports this assignment. Results obtained during isochronal annealing of the irradiated samples suggest the possible involvement of a divacancy in the formation of an iron–phosphorus pair in silicon.





Subject: Defects in Cz and FZ-Si

INSTITUTE OF PHYSICS PUBLISHING — JOURNAL OF PHYSICS: CONDENSED MATTER

J. Phys.: Condens. Matter 16 (2004) L79–L84 — PII: S0953-8984(04)73996-X

LETTER TO THE EDITOR

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Institute for Materials Research, Tohoku University, Sendai 980-8577, Japan

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Abstract

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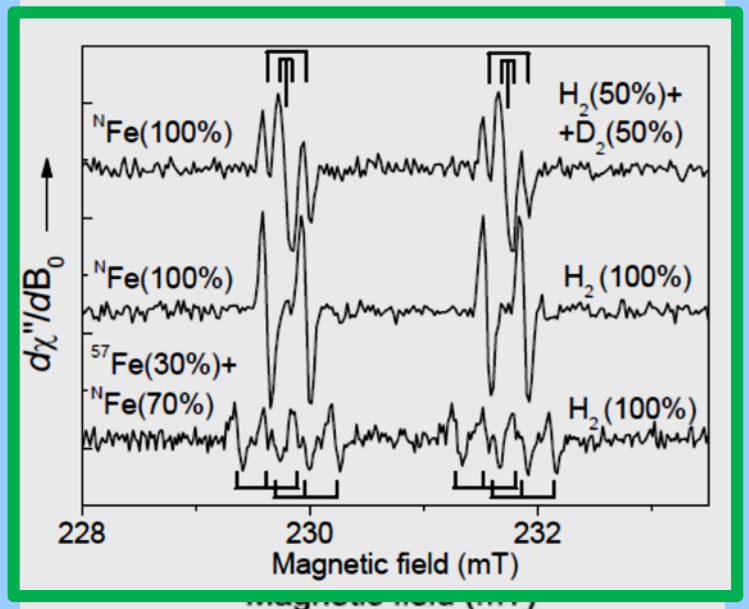
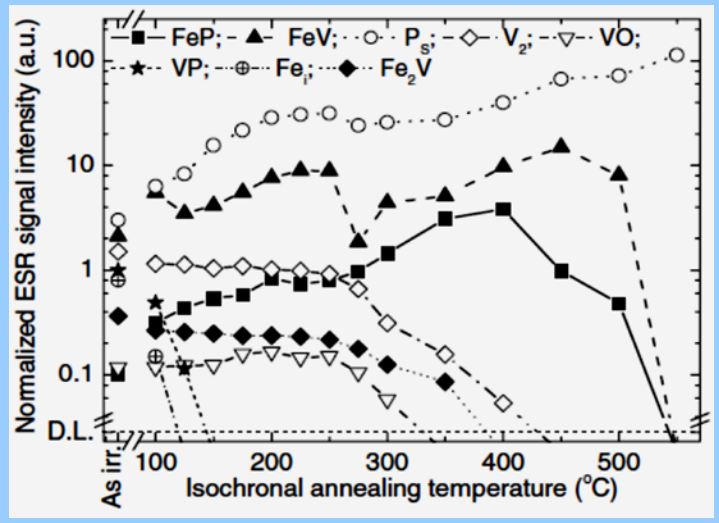
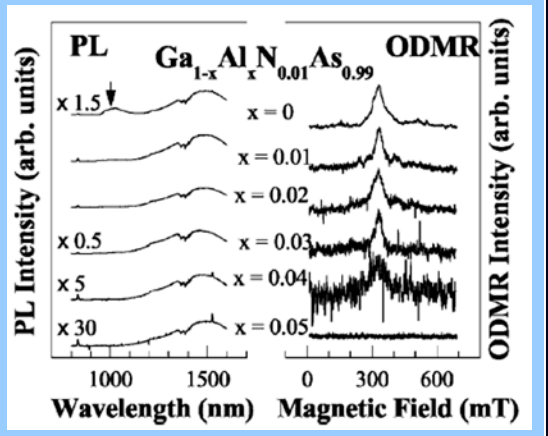
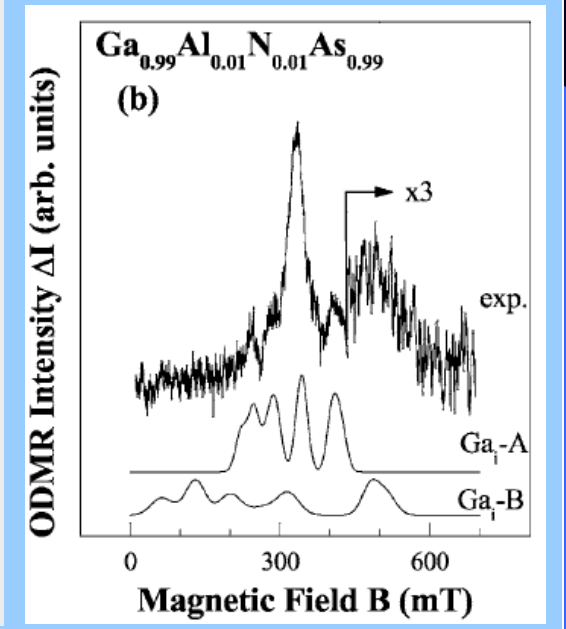




Subject: Defects in dilute nitrides

Affiliation: Institute for Phys. & Meas. Tech.
Country: Sweden; **Period**: 2004-05
Positions: Visiting researcher
Publications: 5 manuscripts





PHYSICAL REVIEW B 73, 125204 (2006)

Optically detected magnetic resonance studies of point defects in Ga(Al)NAs

I. P. Vorona,* T. Mchedlidze, D. Dagnelund, I. A. Buyanova, and W. M. Chen†
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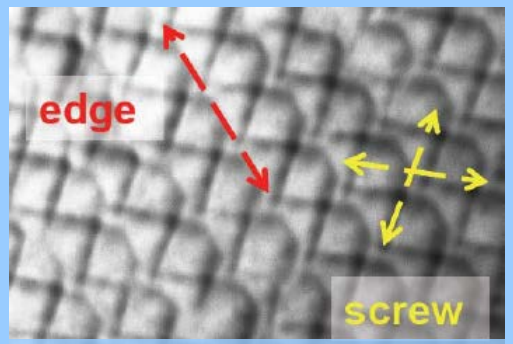
Fraunhofer-Institut für Angewandte Festkörperphysik, Tullastrasse 72, D-79108 Freiburg, Germany
(Received 13 December 2005; revised manuscript received 8 March 2006; published 30 March 2006)

An optically detected magnetic resonance (ODMR) study of Ga(Al)NAs alloys grown by molecular beam epitaxy on GaAs substrates is presented. A number of grown-in defects were observed which act as nonradiative recombination centers. A detailed analysis of experimental data using a spin Hamiltonian leads to the identification of two Ga_i defects. A comparison with similar defects in other phosphide-based diluted nitride *III-V* compounds, such as GaAlNP and GaInNP, allows us to obtain additional information about the nearest surrounding of the defects. A discussion of possible models for other defects observed in the experiments is also presented.

DOI: 10.1103/PhysRevB.73.125204 PACS number(s): 76.70.Hb, 61.72.Ji, 71.55.Eq

Subject: Si technology and applications

Affiliation: JointLab IHP-BTU
Country: Germany; **Period**: 2005-11
Positions: Researcher
Publications: 36 manuscripts



- Properties of agglomerates of intrinsic defects in silicon.
- Si based light – emitting devices, Si photonics. Stark effect for Si-DPL.
- Si wafer direct bonding, regular dislocation networks.
- Fe-P complexes in Si and gettering mechanisms for PV applications
- Band structure engineering in Si for photonic and PV applications.
- Defect control and defect engineering for photonic and PV applications.
- Characterization and development of Si PV materials (mc-Si, thin films, 3rd generation PV materials).
- Properties of Crystal Silicon on Glass films for PV and development of related technology.
- Characterization of CuInSe thin films for photovoltaic (PV) applications.
- Light-induced Solid Phase Crystallization of thin Si films and nano-structures.

Subject: Si technology and applications

Dislocation networks

DOI: 10.1002/smll.200600539

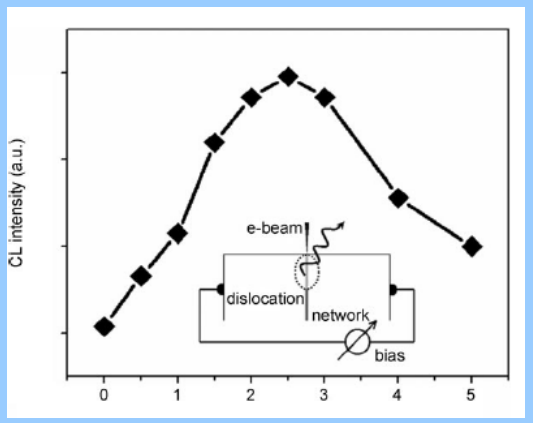
Regular Dislocation Networks in Silicon as a Tool for Nanostructure Devices used in Optics, Biology, and Electronics

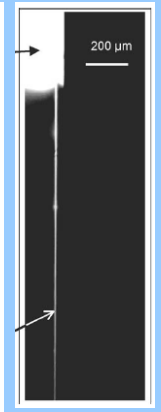
M. Kittler, X. Yu, T. Mchedlidze, T. Arg[illegible]enko, W. Seifert, M. Reiche, T. Wilhelm, M. S[illegible]olff, and W. Fritzsche*

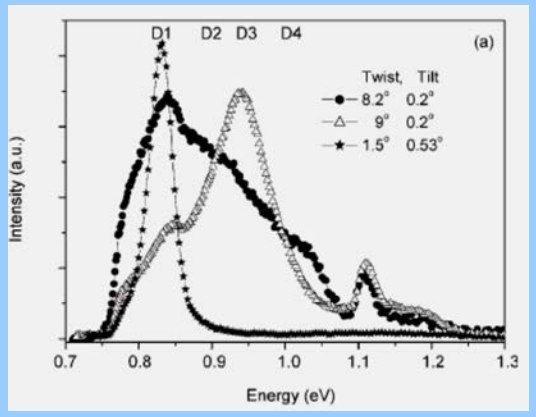
3rd on citations: 71

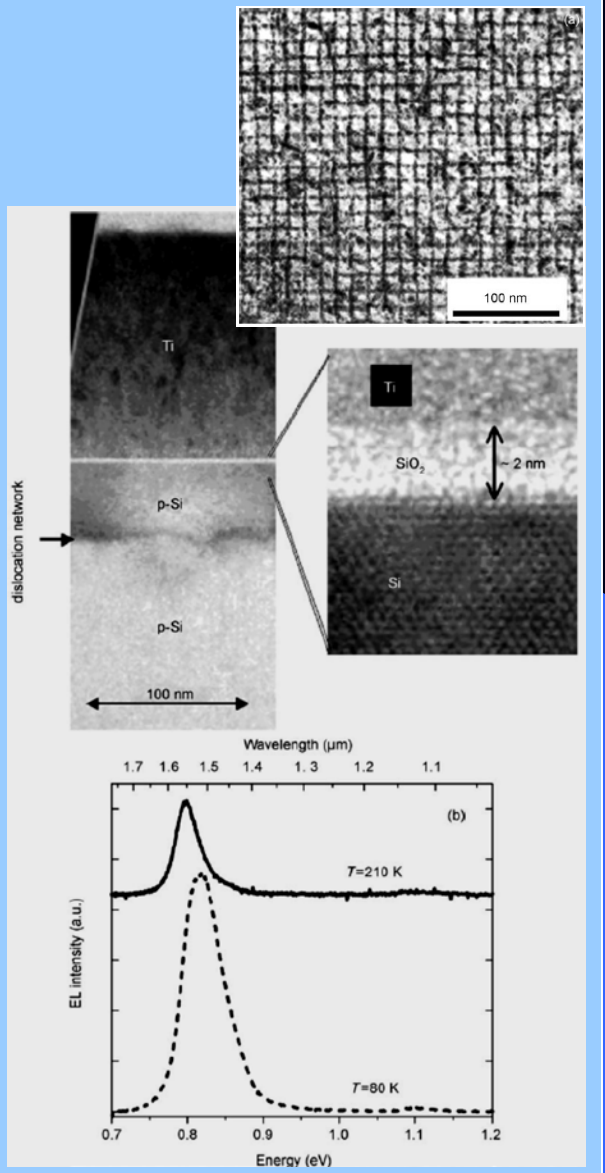
Well-controlled fabrication of dislocation networks in Si using direct wafer bonding opens broad possibilities for nanotechnology applications. Concepts of dislocation-network-based light emitters, manipulators of biomolecules, gettering and insulating layers, and three-dimensional buried conductive channels are presented and discussed. A prototype of a Si-based light emitter working at a wavelength of about 1.5 μm with an efficiency potential estimated at 1% is demonstrated.

Keywords:
- biomolecules
- dislocation networks
- LEDs
- semiconductors
- silicon









Subject: Si technology and applications

APPLIED PHYSICS LETTERS 89, 053111 (2006)

Residual stress in Si nanocrystals embedded in a SiO_2 matrix

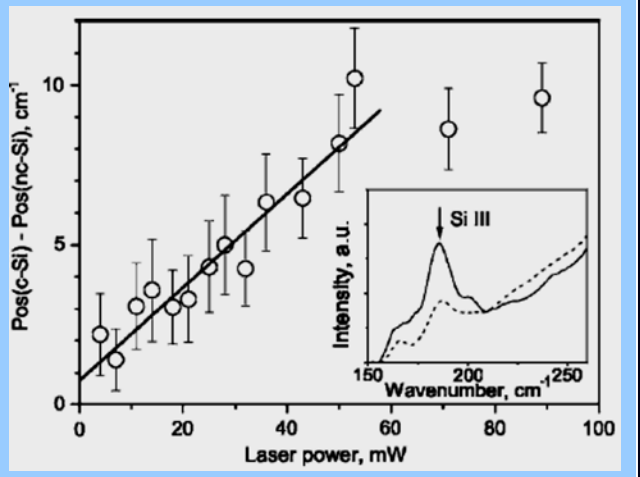
T. Arguirov,[a] T. Mchedlidze, and M. Kittler
IHP, Im Technologiepark 25, D-15236 Frankfurt (Oder), Germany and IHP/BTU Joint Lab, Konrad Wachsmann Allee 1, D-03046 Cottbus, Germany

R. Rölver, B. Berghoff, M. Först, and B. Spangenb
Institute of Semiconductor Electronics, RWTH Aachen U 2074 Aachen, Germany

(Received 23 March 2006; accepted 13 Ju lished online 2 August 2006)

Multiple quantum wells consistin ng Si and SiO_2 layers were studied by means of Raman scattering. The struct bricated by the remote plasma enhanced chemical vapor deposition of amorpho $_2$ layers on quartz substrate. The structures were subjected to a rapid thermal annea ure for Si crystallization. The obtained results suggest that the Si layers consist of nan stals embedded in an amorphous Si phase. It was found that the silicon nanocrystals inside 2 nm thin layers are under high residual compressive stress. Moreover, the metastable Si III phase was detected in these samples supporting the presence of large compressive stresses in the structures. The compressive stress could be relaxed upon local laser annealing.

1st on citations: 85



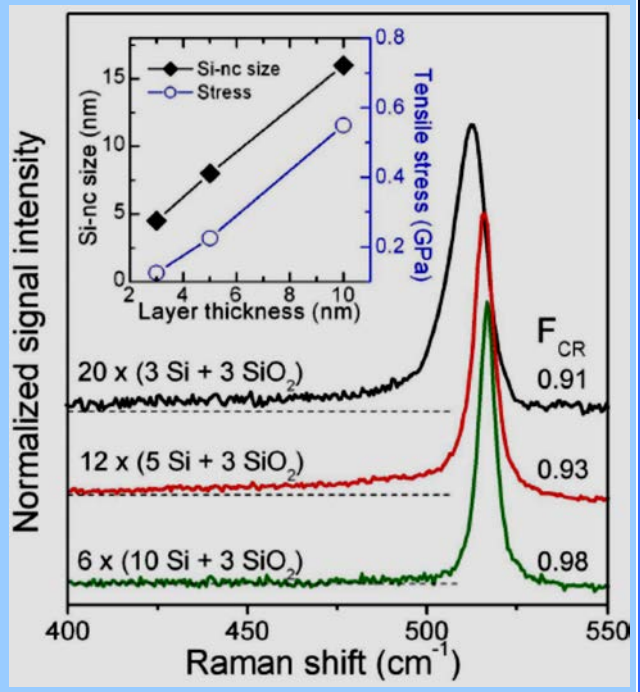
PHYSICAL REVIEW B 77, 161304(R) (2008)

Light-induced solid-to-solid phase transformation in Si nanolayers of Si-SiO_2 multiple quantum wells

T. Mchedlidze,* T. Arguirov, S. Kouteva-Arguirova, and M. Kittler
IHP Microelectronics, Im Technologiepark 25, D-15236 Frankfurt (Oder), Germany and IHP/BTU Joint Laboratory, Konrad-Wachsmann-Allee 1, D-03046 Cottbus, Germany

R. Rölver, B. Berghoff, D. L. Bätzner, and B. Spangenberg
Institute of Semiconductor Electronics, RWTH Aachen University, D-52074 Aachen, Germany
(Received 4 March 2008; published 11 April 2008)

Amorphous Si was completely transformed to a nanocrystalline phase in nanometer thick layers of Si-SiO_2 multiple quantum wells deposited on quartz substrates employing an illumination with a continuous-wave laser. The process was controlled by micro-Raman spectroscopy. Preferential heating of amorphous Si due to selective light absorption in the employed range of laser radiation wavelengths and solid-to-solid phase transformation can explain the obtained results.



Subject: Si technology and applications

APPLIED PHYSICS LETTERS 89, 053111 (2006)

Residual stress in Si nanocrystals embedded in a SiO_x matrix

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Institute of Semiconductor Electronics, RWTH Aachen University, D-52074 Aachen, Germany
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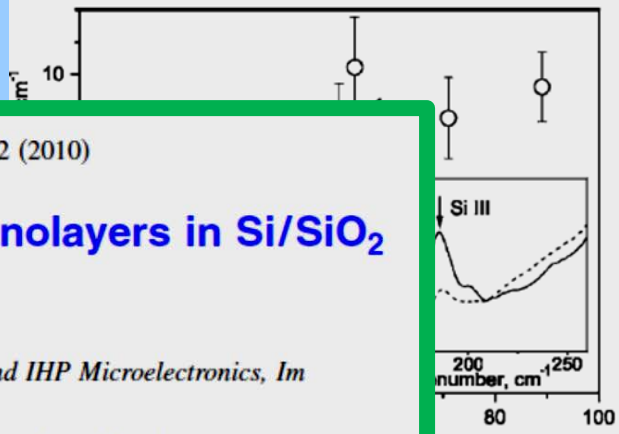


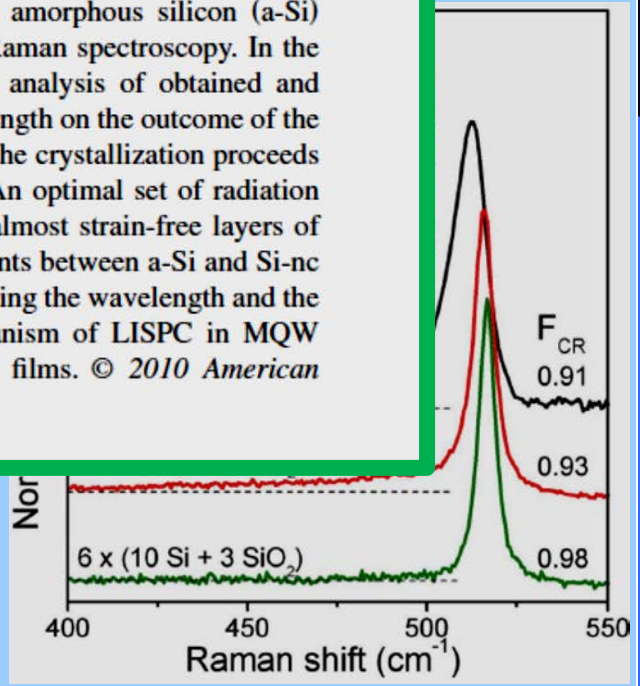
JOURNAL OF APPLIED PHYSICS **107**, 124302 (2010)

Light induced solid-phase crystallization of Si nanolayers in Si/SiO_2 multiple quantum wells

T. Mchedlidze, T. Arguirov, S. Kouteva-Arguirova, and M. Kittler
Joint Lab IHP/BTU, Konrad-Wachsmann-Alle 1, D-03046 Cottbus, Germany and IHP Microelectronics, Im Technologiepark 25, D-15236 Frankfurt (Oder), Germany

(Received 8 December 2009; accepted 11 May 2010; published online 16 June 2010)

The process of light-induced crystallization (LIC) of nanometer-thick amorphous silicon (a-Si) layers in Si/SiO_2 multiquantum wells (MQW) was investigated using Raman spectroscopy. In the present investigations, a laser was employed as the light source. An analysis of obtained and previously published results suggests strong influence of radiation wavelength on the outcome of the process. Namely, for certain ranges of wavelengths and radiation fluxes the crystallization proceeds through the light-induced solid phase crystallization (LISPC) process. An optimal set of radiation wavelength and flux values allows formation of fully crystallized and almost strain-free layers of nanocrystalline silicon (Si-nc). The difference in the absorption coefficients between a-Si and Si-nc was considered responsible for the obtained results. A mechanism explaining the wavelength and the radiation flux dependence was proposed. Understanding of the mechanism of LISPC in MQW structures would allow improving the LIC processes for thin silicon films. © *2010 American Institute of Physics*. [doi:10.1063/1.3446831]



Subject: Si technology and applications

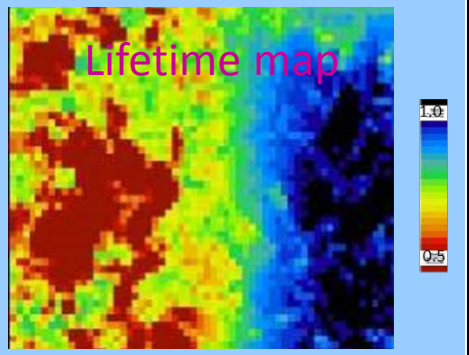
JOURNAL OF APPLIED PHYSICS 111, 073504 (2012)

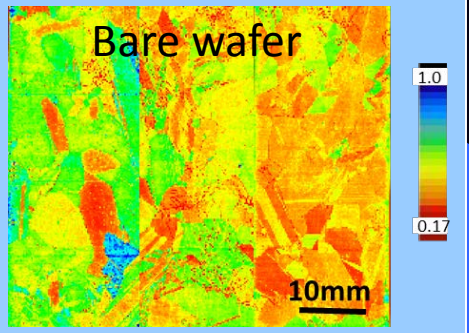
Capability of photoluminescence for characterization of multi-crystalline silicon

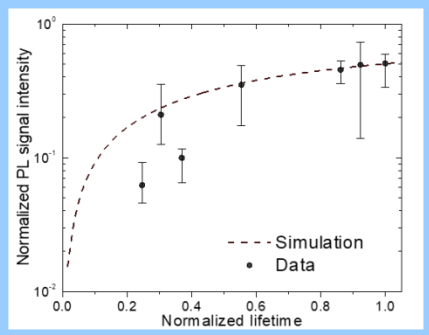
T. Mchedlidze,[1,a)] W. Seifert,[2] M. Kittler,[1,2] A. T. Blumenau,[3] B. Birkmann,[3] T. Mono,[3] and M. Müller[3]
[1]*Joint Lab IHP/BTU, Konrad-Wachsmann-Allee 1, D-03046 Cottbus, Germany*
[2]*IHP, Im Technologiepark 25, D-15236 Frankfurt (Oder), Germany*
[3]*SCHOTT Solar Wafer GmbH, Ilmstr. 8, 07743 Jena, Germany*

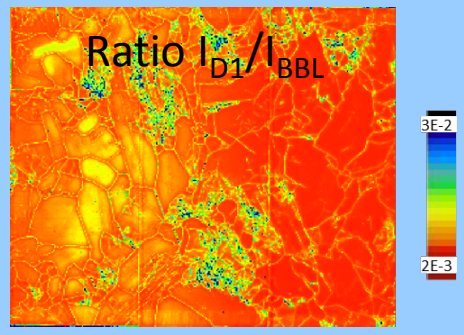
(Received 18 November 2011; accepted 28 February 2012; published online 2 April 2012)

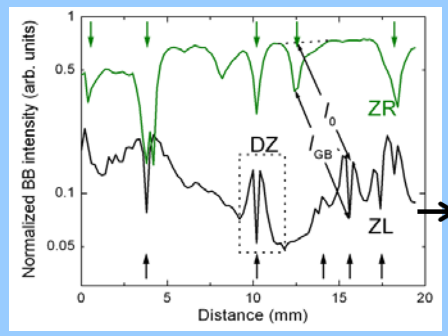
Application of various characterization methods for the investigation of photovoltaic materials allows fast progress in perfection of their quality. However, capabilities of the methods should be clearly understood and the methods should be applied in the correct manner to avoid false and/or unreliable interpretation of the results. We applied photoluminescence (PL) for characterization of multi-crystalline silicon (mc-Si) samples and compared the obtained results with carrier lifetime measurement data for the same samples. The analyses revealed strong influence of surface recombination and optical shadowing from grain boundaries on the interpretation of the PL results. Proper surface passivation allows application of defect-related luminescence for the characterization of mc-Si along with traditionally used band-to-band luminescence. © *2012 American Institute of Physics*. [http://dx.doi.org/10.1063/1.3699275]

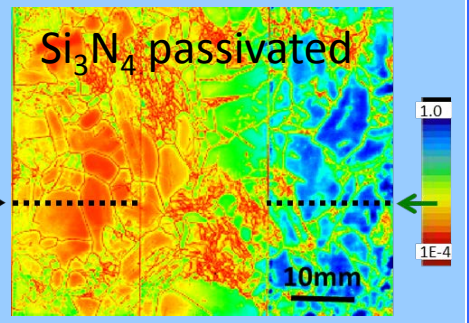






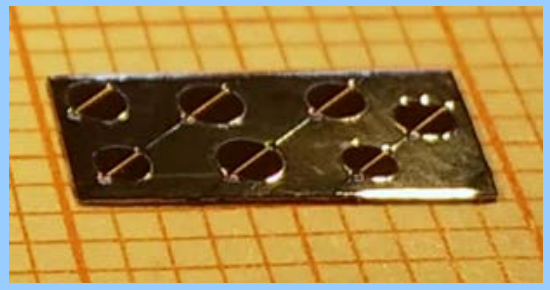






Subject: Si technology and applications

Affiliation: Technische Universität Dresden
Country: Germany; **Period**: 2012-21
Position: Researcher
Publications: 18 manuscripts



- Development of PV-material characterization technique.
- Simulation of PV-cell fabrication processes and thermal budget.
- Iron-related defects in solar cells.
- Capability of DLTS for characterizing multi-crystalline silicon.
- Near-Junction volume defects in Si solar cells.
- Light- and current-induced degradation of solar cells (LID).
- Solar cell degradation induced by light and elevated temperatures (LETID).
- Photoconductive (FTIR) detection of defects in ultrathin layers.
- Capacitance transient spectroscopy measurements on high-k metal gate field effect transistors fabricated using 28nm technology node.
- Characterization of fully depleted HKMG SOI FET structures using capacitance transient and subthreshold swing measurement methods.

Subject: Si technology and applications

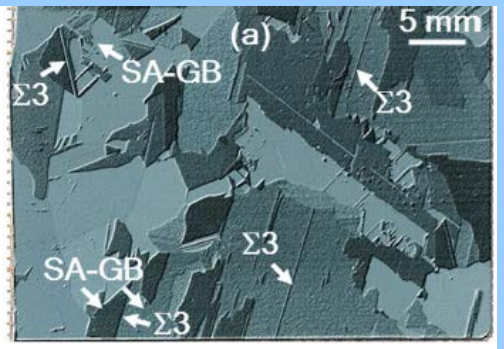
JOURNAL OF APPLIED PHYSICS **115**, 012006 (2014)

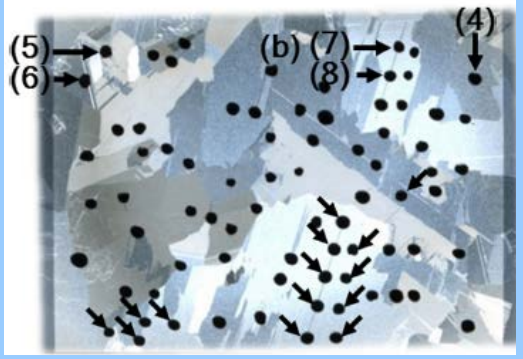
On the capability of deep level transient spectroscopy for characterizing multi-crystalline silicon

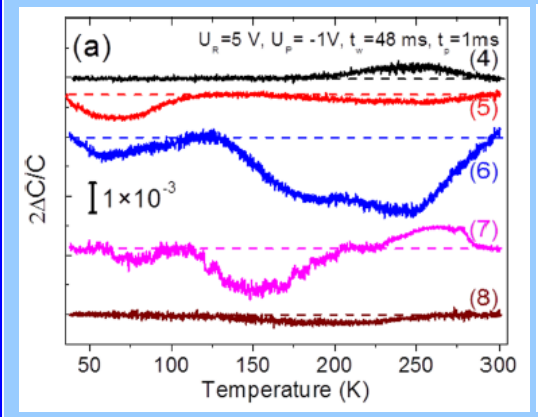
T. Mchedlidze, M. Nacke, E. Hieckmann, and J. Weber
Technische Universität Dresden, 01062 Dresden, Germany

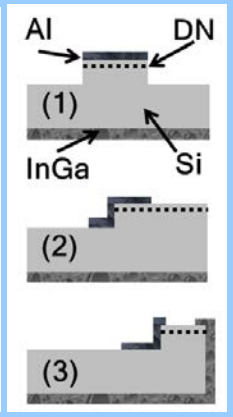
(Received 16 July 2013; accepted 16 September 2013; published online 2 January 2014)

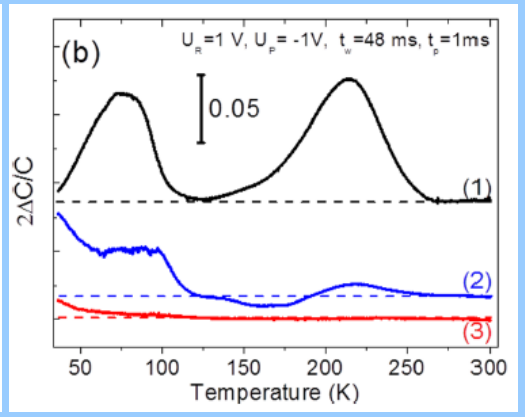
The suitability of the deep level transient spectroscopy (DLTS) technique in exploring locations with high and degraded carrier lifetimes containing grain-boundaries (GBs) in multicrystalline silicon (mc-Si) wafers was studied. The types and locations of GBs were determined in mc-Si samples by electron backscatter diffraction. Mesa-type Schottky diodes were prepared at (along) GBs and at reference, GB-free locations. Detected DLTS signals varied strongly along the same GB. Experiments with dislocation networks, model structures for GBs, showed that GB-related traps may be explored only using special arrangement of a GB and the diode contacts. Iron-related carrier traps were detected in locations with degraded carrier lifetimes. Densities of the traps for near-GB and for GB free locations were compared to the lifetime measurement results. © *2014 AIP Publishing LLC*. [http://dx.doi.org/10.1063/1.4837997]

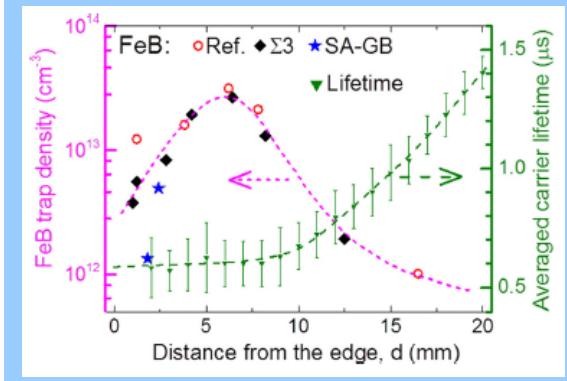












Subject: Si technology and applications

ORIGINAL PAPER *Phys. Status Solidi A* **2019**, 1900142

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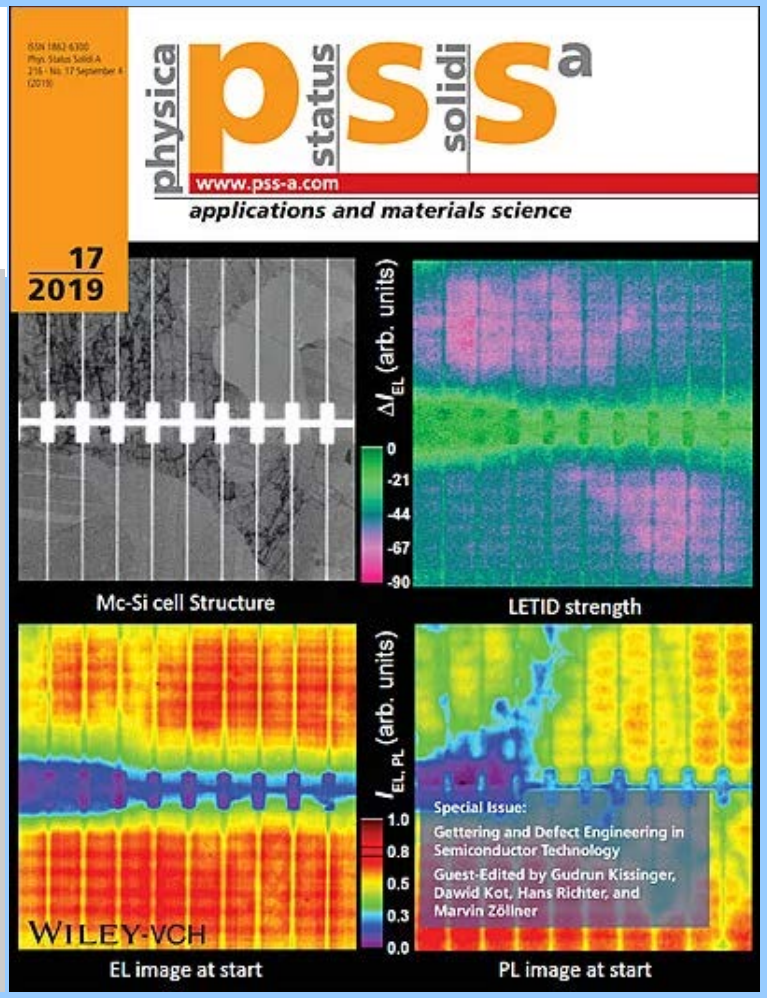
Location and Properties of Carrier Traps in mc-Si Solar Cells Subjected to Degradation at Elevated Temperatures

Teimuraz Mchedlidze and Joerg Weber*

Multi-crystalline Si (mc-Si) solar cells subjected to carrier-induced efficiency degradation at elevated temperatures are studied using deep-level transient spectroscopy (DLTS), capacitance-voltage, and electroluminescence (EL) measurements. Commercially available passivated emitter and rear cell (PERC) mc-Si solar cells are investigated after short annealing in the dark (at $T = 200\,^{\circ}C$ for 20 min), after degradation by a constant forward current at 70 °C, and after regeneration annealing at 200 °C for 20 min. The degradation is detected in situ by EL imaging of the surface of the cell. Several $n^{+}p$ mesa-diodes, selectively fabricated on the front surface of the solar cell, allow the characterization of locations with various levels of degradation and density of extended defects. The degree of the degradation correlates with the local active boron concentration. At all stages, traps associated with extended defects (i.e., dislocations, grain boundaries, precipitates, etc.) are detected by DLTS, and these traps are not affected by changes in the degree of degradation. Two minority-carrier traps with energy level positions in the bandgap at Ec −0.19 eV and Ec −0.34 eV are detected only in the degraded solar cells in concentrations that correlate with the local degree of cell degradation.



Subject: Si technology and applications

Phys. Status Solidi A **214**, No. 7, 1700182 (2017) / **DOI** 10.1002/pssa.201700182

Interface traps in 28 nm node field effect transistors detected by capacitance transient spectroscopy

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applications and materials science

Teimuraz Mchedlidze[*,1], **Maximilian Drescher**[2], **Elke Erben**[3], **and Jörg Weber**[1]

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Keywords capacitance transient spectroscopy, device characterization, field effect transistors, interface trap density

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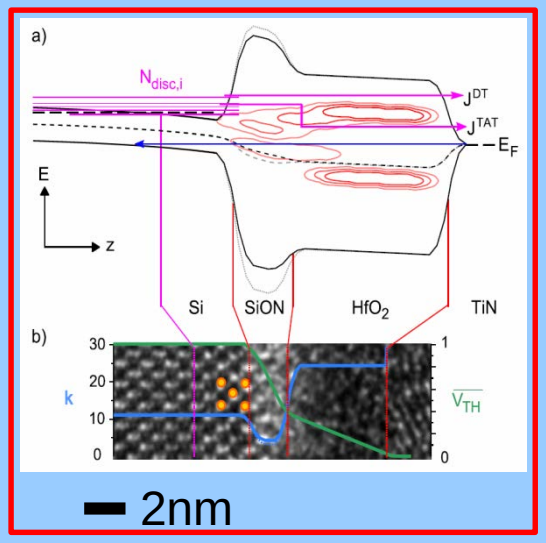
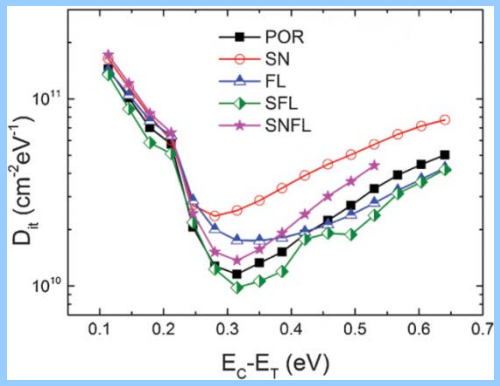
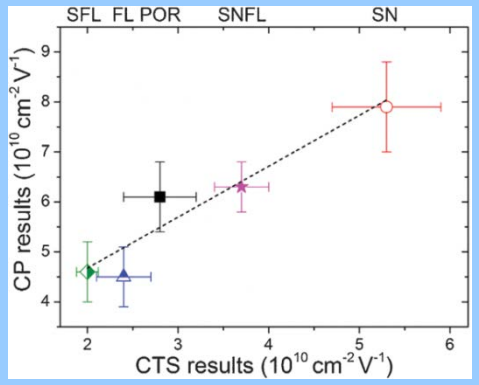
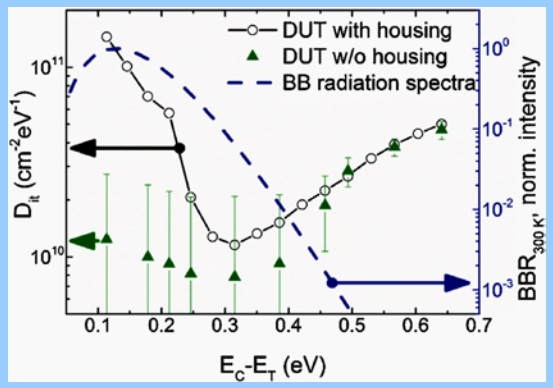
The energy distribution of the interface trap density for high-k metal gate field effect transistors, fabricated in the standard 28 nm node technology and subjected to various fabrication processes was obtained using the capacitance transient spectroscopy (CTS) method. The CTS results show a nice correspondence with those obtained by the characterization methods routinely used in semiconductor industry, but contain more information. Strong influence of the infrared illumination on the results of the CTS measurements was detected at temperatures $T < 200$ K. Therefore, a proper shielding from infrared irradiation is required during transient spectroscopy measurements at low temperatures.









Subject: Si technology and applications

ORIGINAL PAPER *Phys. Status Solidi A* **2020**, *217*, 2000625

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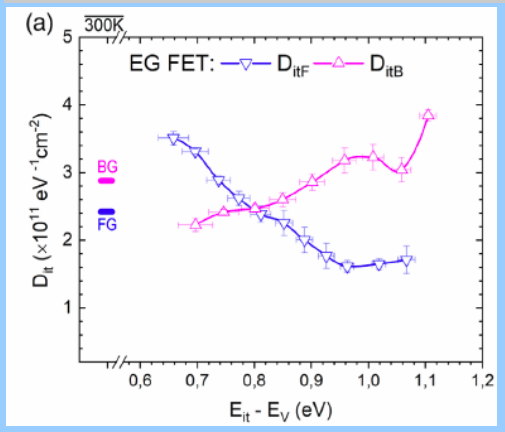
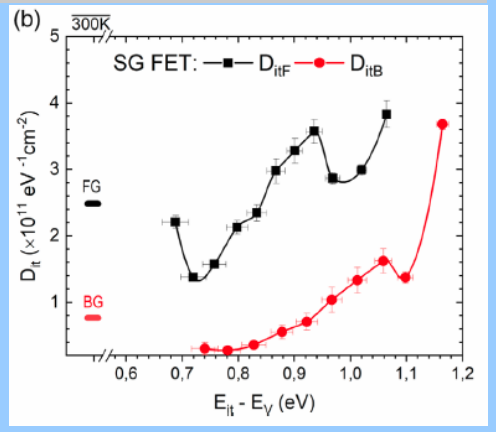
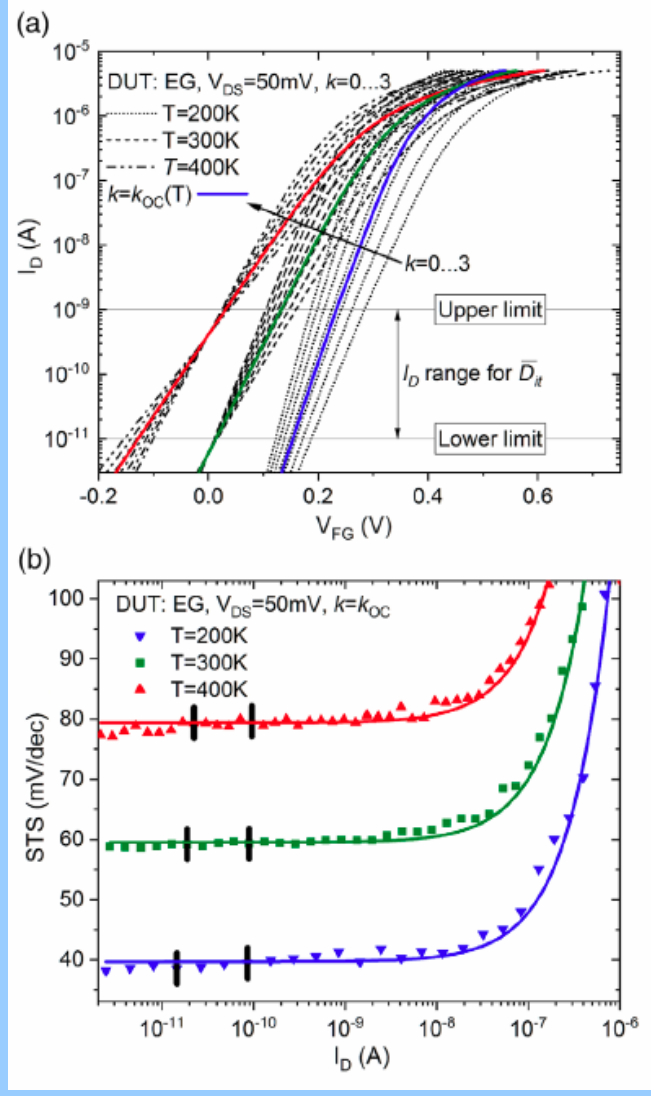
Characterization of Ultrathin Fully Depleted Silicon-on-Insulator Devices Using Subthreshold Slope Method

Teimuraz Mchedlidze and Elke Erben*

The subthreshold current–voltage (subthreshold slope) characteristic of a fully depleted silicon-on-insulator high-*k* dielectric-metal gate field-effect transistor is applied for evaluation of the interface traps located at both the front and back channels. The proposed characterization method allows an estimation of averaged trap densities separately for the front and back interfaces of the channel. Performing subthreshold slope measurements at several temperatures allows the extraction of the energy distributions of the interface trap densities for both interfaces and obtaining essential characteristics of the stack.

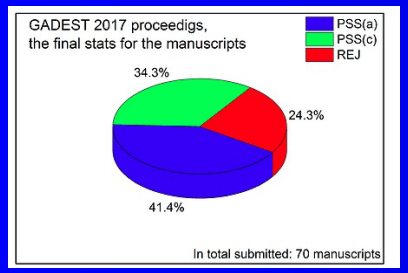


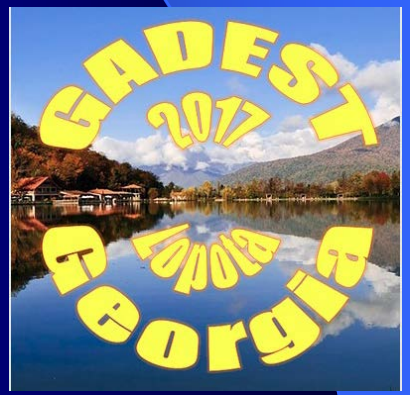




GADEST'17, Lopota, Georgia

- Dates 01-06 October 2017.
- 96 participants from 23 countries.
- 9 Leading semiconductor companies.
- 46 scientific institutions.
- 53 conference publications in: PSSa (29) & PSSc (24).
- 61 oral presentations (21 invited).
- 39 Poster presentations.





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Summary (formal)

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i10 –index: 47
Publications >125
Citations > 1210
Presentations > 70