

Gettering and Defect Engineering in
Semiconductor Technology XVI

GADEST 2015

Final Program
September 9th, 2015

Sunday, September 20th

10:00 - 10:35 *Coffee*

Opening session

Chairperson: P. Pichler

10:35 - 10:45 **Conference opening**
P. Pichler

10:45 - 11:30 **Keynote: How basic research on silicon fieldeffect transistors will change our international system of units**
K. von Klitzing

11:30 - 11:50 **Keynote: 30 years of GADEST—Design of materials and functionality**
H. Richter

11:50 - 12:30 **Invited: Solar Cells from Upgraded Metallurgical Silicon**
E. Weber, S. Rein, S. Riepe

12:30 - 14:00 *Lunch*

Session: Solar silicon growth I

Chairperson: H. J. Möller

14:00 - 14:40 **Invited: Recent progress of crystal growth technology for solar silicon ingot**
C. W. Lan

14:40 - 15:00 **50 cm size seed cast Si ingot growth and its characterization**
T. Sekiguchi, Y. Miyamura, H. Harada, K. Jiptner, J. Chen, R. R. Prakash, S. Nakano, K. Kakimoto

15:00 - 15:20 **Understanding the performance of fine grained vs. conventional mc-Si, based on grain size, - orientation and - boundary type distribution**
T. Lehmann, E. Meißner, C. Reimann, J. Friedrich

15:20 - 15:50 *Coffee break*

Session: Solar silicon growth II

Chairperson: C. W. Lan

15:50 - 16:10 **A one step process for the recovery of the electrical properties of “red-zone” wafers for mc-Si solar cells**
G. F. Martins, T. Burton, P. MacDonald, R. S. Bonilla, P. R. Wilshaw

16:10 - 16:30 **Statistical consideration of grain growth mechanism of multicrystalline Si by one directional solidification technique**
R. R. Prakash, K. Jiptner, J. Chen, Y. Miyamura, H. Harada, T. Sekiguchi

16:30 - 16:50 **Defect engineering of cast crystalline silicon based on seed assisted growth**
S. Yuan, X. Yu, D. Hu, Y. Xu, Y. Wan, D Yang

Bus transfer and welcome reception at Rabeneck Castle

Monday, September 21st

Session: Light-induced degradation

Chairperson: R. J. Falster

- 09:00 - 09:40 **Invited: BO-correlated defects: Avoiding degradation of bulk lifetime in crystalline Si by regeneration**
G. Hahn, S. Wilking, A. Herguth
- 09:40 - 10:00 **Discussion of A_{Si} - Si_i -defect model in frame of experimental results on P line in indium doped silicon**
K. Lauer, C. Möller, D. Schulze, C. Ahrens
- 10:00 - 10:20 **New insight into the boron-oxygen defect formation and regeneration**
T. Niewelt, J. Schön, J. Broisch, S. Rein, J. Haunschild, W. Warta, M. C. Schubert
- 10:20 - 10:40 **Comparison of boron-oxygen and copper-related light-induced degradation in silicon**
J. Lindroos, M. Rinio, H. Savin
- 10:40 - 11:10 *Coffee break*

Session: Surface passivation

Chairperson: G. Hahn

- 11:10 - 11:50 **Invited: Valence-mending passivation of Si(100) surface: principle, practice and application**
M. Tao
- 11:50 - 12:10 **Stable, extrinsic, field effect passivation for back contact silicon solar cells**
K. Collett, L. Rands, R. S. Bonilla, G. Martins, R. Lobo, P. R. Wilshaw
- 12:10 - 12:30 **Impact of the gate material on the deep levels in a-Si:H/c-Si Metal-Insulator-Semiconductor capacitors**
E. Simoen, V. Ferro, B.J. O'Sullivan
- 12:30 - 14:00 *Lunch*

Session: Gettering

Chairperson: H. Savin

- 14:00 - 14:40 **Invited: Defect interactions in semiconductors for photovoltaics**
M. Seibt, A. Ahrens, J. Clemens, M. A. Falkenberg, P. Krenckel, P. Saring, M. Korosheva, V. Kveder
- 14:40 - 15:20 **Invited: Gettering and passivation of bulk defects in silicon photovoltaic materials**
J. Murphy, M. Al-Amin
- 15:20 - 15:40 **Enhanced internal gettering of iron in n/n+ epitaxial silicon wafer: Effect of high temperature rapid thermal annealing in nitrogen ambient**
P. Dong, X. Liang, D. Tian, X. Ma, D. Yang
- 15:40 - 16:10 *Coffee break*

Session: Dislocations in semiconductors

Chairperson: M. Seibt

- 16:10 - 16:50 **Invited: Structure and properties of dislocations in bilayer graphene**
E. Spiecker, B. Butz, C. Dolle, F. Niekietel, K. Weber, D. Waldmann, B. Meyer, H. B. Weber
- 16:50 - 17:10 **Spatial distribution of the dislocation trails in silicon**
V. I. Orlov, E. B. Yakimov, N. Yarykin
- 17:10 - 17:30 **Orientation dependency of dislocation generation in Si growth process**
K. Jiptner, Y. Miyamura, H. Harada, R. R. Prakash, B. Gao, K. Kakimoto, T. Sekiguchi
- 17:30 - 17:50 **Interplay of Ni and Au atoms with dislocations and vacancy defects generated by moving dislocations in Si**
V. V. Kveder, M. A. Khorosheva, M. Seibt
- 17:50 - 18:10 **Electronic properties of dislocations**
M. Reiche, M. Kittler, E. Pippel, H. Kosina, A. Lugstein, H. Uebensee
- 18:10 - 19:10 *Dinner*

Session: Poster Session I

- 19:10 **Potential synthesis of solar-grade silicon from rice husk ash**
B. O. Ayomanor, K. D. Vernon-Parry
- 19:10 **Investigation into efficiency-limiting defects in mc-Si solar cells**
O. A. Al-Ani, A. M. A. Sabaawi, J. P. Goss, N. E. B. Covern, P. R. Briddon, M. J. Rayson
- 19:10 **Investigation of parasitic surface recombination mechanisms in high-lifetime oxidised n-Si**
R. S. Bonilla, G. Martins, P. R. Wilshaw
- 19:10 **Low temperature activation of grown-in defects limiting the lifetime of high purity float-zone silicon wafers**
N. E. Grant, F. E. Rougieux, D. Macdonald
- 19:10 **Investigation of ZnMnTeO solar cells materials on the base of ZnMnTe**
L. Trapaidze, M. Sharvashidze, T. Butkhuzi, N. Gapishvili, T. Khulordava, E. Kekelidze
- 19:10 **Characterization of Si converters of beta-radiation in the scanning electron microscope**
M.A. Polikarpov, E.B. Yakimov
- 19:10 **Kinetic model of precipitate growth during phase separation in metastable binary solid solutions**
A. Sarikov
- 19:10 **Effect of oxygen precipitation on the carrier transportation in Czochralski silicon**
P. Dong, X. Ma, D. Yang
- 19:10 **Segregation gettering of nickel in p/p+ silicon wafers**
K. Torigoe, T. Ono, K. Nakamura
- 19:10 **Search for effective sites of proximity gettering in Si wafers by first principles calculation**
S. Shirasawa, K. Sueoka
- 19:10 **Misfit dislocation free epitaxial growth of SiGe on compliant nano-structured silicon**
P. Zaumseil, Y. Yamamoto, M. A. Schubert, G. Capellini, T. Schroeder

- 19:10 **Influence of the electrolyte composition on anisotropy of pore formation rate in p-Si**
Yu. A. Zharova, E.V. Astrova
- 19:10 **Coulomb impurity effects on optical property of ellipsoidal quantum dots in semiconductor**
Z. S. Machavariani, T. Tchelidze
- 19:10 **ZnO nanoparticles formation in 64Zn^+ ion implanted Al_2O_3**
V. V. Privezentsev, V. S. Kulikauskas, A. A. Batrakov, A. Yu. Trifonov, E. A. Shteinman, A. V. Tereschenko
- 19:10 **Silicon germanium interdiffusion in SiGe in presence of defects and dopants**
C. Zechner, N. Zographos
- 19:10 **Modeling the post-implantation annealing of platinum**
E. Badr, P. Pichler, G. Schmidt
- 19:10 **Defect formation in ion-implanted Si—Approach to controlled semiconductor optical properties**
N. Khuchua, M. Tigishvili, R. Melkadze, N. Dolidze, N. Gapishvili, Z. Jibuti, G. Dovbeshko, V. Romanyuk
- 19:10 **Dopant profiling by C-V and Q-V methods extended to the lightly doped samples**
A. Czett, Cs. Buday, F. Korsós, M. Myronov, M. Wilson, S. Savtchouk
- 19:10 **Non-visual defect monitoring with surface voltage mapping: application for semiconductor IC and PV technology**
P. Edelman, D. Marinskiy, A. Savtchouk, J. D'Amico, A. Findlay, M. Wilson, C. Almeida, J. Lagowski

Tuesday, September 22nd

Session: Czochralski silicon growth

Chairperson: W. von Ammon

09:00 - 09:40 **Invited: Growth of Czochralski silicon crystals having ultralow carbon concentrations**
Y. Nagai, K. Kashima, S. Nakagawa, M. Higasa

09:40 - 10:00 **Electrically inactive dopants in heavily doped as-grown Czochralski silicon**
L. Stockmeier, M. Elsayed, R. Krause-Rehberg, M. Zschorsch, L. Lehmann, J. Friedrich

10:00 - 10:20 **Theoretical study of the impact of stress and interstitial oxygen on the behavior of intrinsic point defects in growing CZ-Si crystals**
K. Sueoka, K. Nakamura, J. Vanhellefont

10:20 - 10:50 *Coffee break*

Session: Transition metals in silicon

Chairperson: V. Kveder

10:50 - 11:30 **Invited: Internal gettering of copper for microelectronic applications**
G. Kissinger, D. Kot, M. A. Schubert, A. Sattler, T. Müller

11:30 - 11:50 **Fast detection method of copper contamination in silicon**
A. Inglese, H. Savin

11:50 - 12:10 **Interaction of interstitial copper with isolated vacancies in silicon**
N. Yarykin, J. Weber

12:10 - 12:30 **Detection and prevention of palladium contamination in silicon devices**
M. L. Polignano, I. Mica, A. Brambilla, C. Brambilla, S. Brambilla, M. Ceresoli, D. Codegoni, L. Farini, F. Somaini

12:30 - 14:00 *Lunch*

Session: Iron in silicon

Chairperson: J. D. Murphy

14:00 - 14:40 **Invited: Deep Level Transient Spectroscopy measurements on fabricated device structures**
T. Mchedlidze, J. Weber

14:40 - 15:00 **Mössbauer Spectroscopy on Fe impurities in Si materials**
Y. Yoshida, Y. Ino, K. Tanaka

15:00 - 15:20 **Direct observations of Fe impurities in Si with different Fermi levels by Mössbauer spectroscopy**
Y. Ino, K. Tanaka, K. Sakata, Y. Yoshida

15:20 - 15:40 **Determination of activation energy of the iron acceptor pair association and dissociation reaction**
K. Lauer, C. Möller, M. Auge, D. Schulze

15:40 - 16:10 *Coffee break*

Session: Atomistic defect simulations

Chairperson: S. K. Estreicher

- 16:10 - 16:50 **Invited: Atomistic simulations of microstructure in (and on) silicon**
T. Sinno
- 16:50 - 17:30 **Invited: Theoretical studies on the NV(-) defect in diamond**
P. Deák, M. Kavani, B. Aradi, T. Frauenheim, J.-P. Chou, A. Gali
- 17:30 - 17:50 **Electrical levels and diffusion barriers of early 3d and 4d transition metals in silicon**
A. G. Marinopoulos, P. Santos and J. Coutinho
- 17:50 - 18:10 **Multiscale simulation of photoluminescence defects generated by ion implantation in crystalline Si**
I. Santos, M. Aboy, P. López, L. A. Marqués, L. Pelaz
- 18:10 - 19:10 *Dinner*

Session: Poster Session II

- 19:10 **Electrical properties of defects in Ga-doped Ge irradiated with fast electrons and protons**
V. V. Emtsev, N. V. Abrosimov, V. V. Kozlovski, G. A. Oganessian
- 19:10 **Carbon-hydrogen complexes in n- and p-type SiGe-alloys studied by Laplace deep level transient spectroscopy**
R. Stübner, Vl. Kolkovsky, J. Weber, N. Abrosimov
- 19:10 **Effect of nitrogen-doping on the properties of radiation defect centers in FZ silicon**
P. Kamiski, R. Kozłowski, B. Surma, M. Kozubal, C. Hindrichsen, T. Sveigaard, L. Jensen, M. Kwestarz, J. Jabłoński
- 19:10 **Boron-related defects in low temperature irradiated silicon**
L. I. Khirunenko, M. G. Sosnin, A.V. Duvanskii, N.V. Abrosimov, H. Riemann
- 19:10 **Thermally stable vacancy complexes in silicon n-FZ-Si(P) irradiated with 0.9 MeV electrons and 15 MeV protons**
N. Arutyunov, M. Elsayed, R. Krause-Rehberg, V. Emtsev, G. Oganessian, V. Kozlovski
- 19:10 **Metastable defects in proton implanted and annealed silicon**
M. Jelinek, J. G. Laven, N. Ganagona, R. Job, W. Schustereder, H.-J. Schulze, M. Rommel, L. Frey
- 19:10 **Hydrogen-vacancy complexes and their deep states in n-type silicon**
I. L. Kolevatov, F. Herklotz, V. Bobal, B. G. Svensson, E. V. Monakhov
- 19:10 **Oxygen-related defects formed upon thermal double donor annihilation in silicon: FTIR and DLTS studies**
L. I. Murin, E. A. Tolkacheva, V. P. Markevich, A. R. Peaker, B. G. Svensson
- 19:10 **Effect of deep level defects on the performance of Si high voltage picosecond range avalanche diodes**
V. Brulevskij, P. Brunkov, I. Smirnova, P. Rodin, I. Grekhov
- 19:10 **Electrical characterization of femtosecond laser pulsed sulfur doped silicon**
A. Ahrens, P. Saring, A. L. Baumann, S. Kontermann, M. Seibt
- 19:10 **Interstitial radiation defects in copper-doped silicon**
N. Yarykin, J. Weber

- 19:10 **Spin relaxation times of donor centers associated with lithium in monoisotopic ^{28}Si**
A. A. Ezhevskii, A. P. Detochenko, S. A. Popkov, A. V. Soukhorukov, D. V. Guseinov, D. G. Zverev, G. V. Mamin, N. V. Abrosimov, H. Riemann
- 19:10 **The impurity spin-dependent scattering effects in the transport and spin resonance of conduction electrons in bismuth doped silicon**
A. V. Soukhorukov, D. V. Guseinov, A. V. Kudrin, S. A. Popkov, A. A. Detochenko, A. V. Koroleva, A. A. Ezhevskii, A.A. Konakov, N. V. Abrosimov, H. Riemann
- 19:10 **Electrical characterization of defects introduced in n-type N-doped 4H-SiC during electron beam exposure**
E. Omotoso, W. E. Meyer, F. D. Auret, S. M. M. Coelho, M. Diale, P. N. M. Ngoepe
- 19:10 **Defect composition in acceptor doped ZnO quantum structures**
T. Tchelidze, T. Kerselidze
- 19:10 **Stress relaxation by strain in the Si-SiO₂ system and its influence on the interface properties**
D. Kropman, T. Kärner, T. Laas, A. Medvid
- 19:10 **Molecular dynamics simulations of intrinsic defects in amorphous Ge**
P. López, D. Calvo, L. A. Marquós, I. Santos, M. Aboy, L. Pelaz
- 19:10 **A density functional study of iron segregation at the ISF and $\Sigma 5$ -(001) grain boundary in mc-Si**
O. A. Al-Ani, J. P. Goss, N. E. B. Cowern, P. R. Briddon, M. Al-Hadidi, A. K. Tiwari, M. J. Rayson
- 19:10 **A new approach for calculating the band gap semiconductors within the density functional method**
V. Gusakov
- 19:10 **Ab initio studies of self interstitials (Mg_i, and Se_i) MgSe wide-gap semiconductor**
E. Igumbor, W. E. Meyer, O. K. Obodo
- 19:10 **Spatially localized vibrational modes of NV⁻ in diamond**
V. J. B. Torres, M. J. Rayson, P. R. Briddon

Wednesday, September 23rd

Session: Heat conduction

Chairperson: T. Sinno

09:00 - 09:40 **Invited: Heat flow and defects in semiconductors: an atomistic study**
S. K. Estreicher, T. M. Gibbons, M. B. Bebek

09:40 - 10:00 **Efficient thermoelectric performance in silicon by vacancy-engineering**
N. M. Wight, S. R. Popuri, J.-W. G. Bos, N. S. Bennett

10:00 - 10:20 **Some comments on the outing to Bamberg**
P. Pichler

10:20 - 10:50 *Coffee break*

Session: Thermal processing

Chairperson: D. Alquier

10:50 - 11:30 **Invited: Thermal processing within milliseconds: semiconductors and beyond**
W. Skorupa

11:30 - 11:50 **III-V integration in Si and Ge by ion beam synthesis and flash lamp annealing**
R. Wutzler, L. Rebohle, S. Prucnal, R. Hübner, S. Facsko, M. Helm, W. Skorupa

11:50 - 12:20 **Pipe organ and defects: A synergistic approach...—An introduction to the organ concert**
W. Skorupa

12:20 - 13:20 *Lunch*

Outing to Bamberg, organ concert, and conference dinner

Thursday, September 24th

Session: Nanoscaled devices and structures I

Chairperson: T. Sekiguchi

09:00 - 09:40 **Invited: Defects in silicon and germanium nanowires**
M. Fanciulli

09:40 - 10:20 **Invited: Ge and GeSn light emitters on Si**
M. Oehme

10:20 - 10:40 **Study of defects in In_{0.53}Ga_{0.47}As/GaAs_{0.5}Sb_{0.5} heterojunction diodes for characterizing trap assisted tunneling**
S. Gupta, E. Simoen, S. El Kazzi, Q. Smets, A. AliReza, R. Rooyackers, A. Vandooren, A. Verhulst, A. Thean, H. Vrielinck, M. Heyns

10:40 - 11:10 *Coffee break*

Session: Oxygen precipitation

Chairperson: D. Yang

11:10 - 11:50 **Invited: Real-time look on the precipitate growth in silicon**
J. Will, A. Gröschel, C. Bergmann, A. Magerl

11:50 - 12:10 **A high-fidelity quantitative model for oxide precipitation in silicon**
Y. Yang, A. Sattler, T. Sinno

12:30 - 14:00 *Lunch*

Session: Advanced characterization methods

Chairperson: P. R. Wilshaw

14:00 - 14:20 **Imaging defect luminescence measurements of 4H-SiC by ultraviolet-photoluminescence**
P. Berwian, D. Kaminzky, K. Roßhirt, B. Kallinger, J. Friedrich, S. Oettel, A. Schneider, M. Schütz

14:20 - 14:40 **Electrical characterization and defect-related luminescence in oxygen implanted silicon**
D. V. Danilov, A. S. Loshachenko, O. F. Vyvenko, N. A. Sobolev, E. I. Shek, P. N. Aruev, V. V. Zabrodskiy

14:40 - 15:00 **Silicon grain boundaries at the nanoscale: an atomic study using APT and HRSTEM**
A. Stoffers, O. Cojocaru-Mirédin, W. Seifert, J. Barthel, D. Raabe

15:00 - 15:20 **Atom probe analysis of iron and oxygen co-clustering in near surface regions of transition metal contaminated single crystal silicon subjected to phosphorus diffusion gettering**
J. O. Douglas, G. F. Martins, A. B. Siddique, J. D. Murphy, P. R. Wilshaw, P. A. J. Bagot, M. P. Moody

15:20 - 15:40 **Comparative investigations of the surface damage of monocrystal-line silicon wafers by Raman spectroscopy and scanning infrared reflection examination**
H. J. Möller, S. Würzner, R. Buchwald, M. Herms, A. Falke, M. Wagner

15:40 - 16:00 **Comparative spatially resolved characterization of a Czochralski-grown silicon crystal by different laser-based imaging techniques**
M. Herms, M. Wagner, A. Molchanov, M. Rommel, M. Zschorsch, S. Wuerzner

16:00 - 16:30 *Coffee break*

Session: Defect studies

Chairperson: T. Mchedlidze

16:30 - 16:50 **Correlation of electron paramagnetic resonance, infrared spectroscopy, Hall and spreading resistance profiling signals of hydrogen related donors**

M. Suckert, P. Niedermayr, M. Berger, H. E. Wagner, H. Ch. Alt, A. R. Stegner, A. Härtl, M. Stutzmann, M. S. Brandt

16:50 - 17:10 **Structure, electronic properties and annealing behavior of diinterstitial-oxygen center in silicon**

V. P. Markevich, A. R. Peaker, B. Hamilton, V. E. Gusakov, S. B. Lastovskii, L. I. Murin, N. Ganagona, E. V. Monakhov, B. G. Svensson

17:10 - 17:30 **Vacancy species produced by rapid thermal annealing of silicon wafers**

V. V. Voronkov, R. Falster

17:30 - 17:50 **Determination of the free Gibbs energy of plate-like precipitates of hydrogen molecules and silicon vacancies formed after H⁺ ion implantation into silicon and annealing**

N. Cherkashin, F.-X. Darras, A. Claverie

17:50 - 18:10 **The efficiency of hydrogen-doping as a function of implantation temperature**

M. Jelinek, J. G. Laven, N. Ganagona, W. Schustereder, H.-J. Schulze, M. Rommel, L. Frey

18:10 *Dinner*

Friday, September 25th

Session: Defects in GaN and SiC

Chairperson: J. Friedrich

09:00 - 09:40 **Invited: GaN power devices: impact of growth and process-induced defects**

D. Alquier, A. Yvon, E. Collard, Y. Cordier, F. Cayrel

09:40 - 10:00 **Investigations of critical structural defects in active layers of GaN-on-Si for power electronic devices**

M. Knetzger, E. Meissner, J. Derluyn, M. Germain, J. Friedrich

10:00 - 10:20 **Radiation damage in 4H-SiC and its effect on power device characteristics**

P. Hazdra, S. Popelka, V. Záhlava, J. Vobecký

10:20 - 10:50 *Coffee break*

Session: Nanoscaled devices and structures II

Chairperson: M. Fanciulli

10:50 - 11:30 **Invited: Low-frequency noise spectroscopy of bulk and border traps in nanoscale devices**

E. Simoen, B. Cretu, W. Fang, M. Aoulaiche, J.-M. Routoure, R. Carin, J. Luo, C. Zhao and C. Claeys

11:30 - 12:10 **Invited: Semiconductor nanoparticle synthesis and functionalization**

J. Veinot

12:10 - 12:30 **Analysis of EL emitted by LEDs on Si substrates containing GeSn/Ge MQW as active layers**

B. Schwartz, P. Saring, M. Kittler, M. Oehme, K. Kosteki, E. Kasper, J. Schulze

12:30 - 12:50 **Photostimulated solid state synthesis of functional oxide materials**

A. Shengelaya, D. Daraselia, D. Japaridze, Z. Jibuti, K. A. Müller

12:50 - 13:00 **Closing**

P. Pichler

13:00 - 14:00 *Lunch*