



Strasbourg (France)

E-MRS Spring Meeting 2004  
May 24-28, 2004

## SYMPOSIUM O

Thin film chalcogenide photovoltaic materials

### Symposium Organizers:

Daniel Lincot, Ecole Nationale Supérieure de Chimie de Paris, France

Hans-Werner Schock, University of Stuttgart, Germany

Ayodhya N. Tiwari, CREST Loughborough University, UK

Alvin D. Compaan, University of Toledo, USA

Takahiro Wada, Ryukoku University, Japan

Papers will be published in Thin Solid Films

# E-MRS 2004 SPRING MEETING

## SYMPOSIUM O

Tuesday, May 25, 2004

Morning

Session I: High efficiency cells & modules

Session chairs: Rommel Noufi, Takahiro Wada

- O-I.1** 09:00 -Invited- PROPERTIES OF HIGH EFFICIENCY CIGS HETEROJUNCTIONS  
**K. Ramanathan**, M.J. Romero, C.S. Jiang and R. Noufi, National Center for Photovoltaics, National Renewable Energy Laboratory, 1617 Cole Boulevard, Golden CO 80401, USA
- O-I.2** 09:30 -Invited- APPROACHES TO FLEXIBLE CIGS THIN-FILM SOLAR CELLS  
**Friedrich Kessler** and Dirk Herrmann, Zentrum fuer Sonnenenergie- und Wasserstoff-Forschung Baden-Wuerttemberg, ZSW Industriestrasse 6, 70565 Stuttgart, Germany
- O-I.3** 10:00 THE EFFECT OF GA-GRADING IN CIGS-BASED THIN FILM SOLAR CELLS  
**O. Lundberg**, M. Edoff, L. Stolt, Ångstrom Solar Center, Solid State Electronics, Uppsala, Sweden
- O-I.4** 10:15 TRANSFER OF Cu(In,Ga)Se<sub>2</sub> THIN FILM SOLAR CELLS TO FLEXIBLE SUBSTRATES  
**C.A. Kaufmann**, A. Neisser, R. Klenk, R. Scheer, Hahn-Meitner-Institut Berlin GmbH, Glienickestrasse 100, 14109 Berlin, Germany
- O-I.5** 10:30 CIGS SOLAR CELLS AND MODULES BY AN ELECTRODEPOSITION PROCESS  
**S. Taunier(a)**, J.F. Guillemoles(a), J. Six-Kurdi(a), A. Chaumont(a), P.P. Grand(a), O. Roussel(a), O. Ramdani(a), D. Guimard(a), C. Hubert(a), JP. Fauvarque(a), N. Bodereau(a), L. Parissi(a), P. Panheleux(a), P. Fanouillère(a), N. Naghavi(a), M. Ben-Farah(a), P. Mogensen(2) D. Lincot(a), O Kerrec(a), (a)Laboratoire Commun « Cellules Solaires en Couches Minces » EDF-CNRS/ENSCP, Plateau CISEL, 6 Quai Watier-BP 49, 78401 Chatou Cedex, France, (b)Saint-Gobain Recherche, Aubervilliers, France
- 10:45 **BREAK**

Session chairs: A. Tiburcio-Silver, Chris Ferekides

- O-I.6** 11:15 -Invited- HIGH-EFFICIENCY Cu(InGa)Se<sub>2</sub> THIN FILM SOLAR CELLS WITH Zn-BASED NOVEL BUFFER LAYER  
**A. Yamada**, H. Miyazaki, Y. Chiba and M. Konagai, Research Center for Quantum Effect Electronics, Department of Physical Electronics, Tokyo Institute of Technology, 2-12-1 O-Okayama, Meguro-ku, Tokyo 152-8552, Japan
- O-I.7** 11:45 SPUTTER-DEPOSITED ZINC-MAGNESIUM OXIDE AS CADMIUM-FREE BUFFER LAYER IN CIGSSE SOLAR CELLS AND MINIMODULES  
**S. Visbeck**, K. Stießberger, T.P. Niesen, J. Palm, V. Probst and F. Karg, Shell Solar GmbH, Muenchen, Germany
- O-I.8** 12:00 -Invited- SOLAR CELLS BASED ON CuInS<sub>2</sub> - AN OVERVIEW  
**R. Klenk**, J. Klaer, R. Scheer, M.Ch. Lux-Steiner, Hahn-Meitner-Institut, Glienickestr. 100, 14109 Berlin, Germany, I. Luck, N. Meyer, U. Rühle, SULFURCELL Solartechnik GmbH, Barbara-McClintock-Str. 11, 12489 Berlin, Germany
- 12:30 **LUNCH**

Tuesday, May 25, 2004

Afternoon

14:00

POSTER SESSION I

Heterojunctions, window layers

Session chair: Ayodhya Tiwari

- O/PI.01** INTERFACE FORMATION BETWEEN  $\text{Cu}(\text{In,Ga})\text{Se}_2$  AND  $\text{CdS}$ : COMPARISON BETWEEN Cu-RICH AND Cu-POOR SURFACE CONDITIONS  
T. Schulmeyer(a), R. Hunger(a), R. Kniese(b), M. Powalla(b), W. Jaegermann(a) and A. Klein(a), (a)Darmstadt University of Technology, Department of Materials Science, Surface Science Division, Petersenstrasse 23, 64287 Darmstadt, Germany, (b)Zentrum für Sonnenenergie und Wasserstoffforschung, Industriestrasse 6c, 70565 Stuttgart, Germany
- O/PI.02** FABRICATION AND CHARACTERIZATION OF  $\text{In}_2\text{S}_3$  THIN FILMS DEPOSITED BY THERMAL EVAPORATION TECHNIQUE  
A. Timoumi, H. Bouzouita, M. Kanzari and B. Rezig, Laboratoire de Photovoltaïque et Matériaux Semi-conducteurs, Ecole Nationale des Ingénieurs de Tunis (E.N.I.T), BP 37 Belvédère, 1002 Tunis, Tunisie
- O/PI.03** COMPARISON STUDY OF ITO THIN FILMS DEPOSITED BY SPUTTERING AT ROOM TEMPERATURE ONTO POLYMER AND GLASS SUBSTRATES  
C. Guillén and J. Herrero, Departamento de Energías Renovables, CIEMAT, Avenida Complutense 22, 28040 Madrid, Spain
- O/PI.04** OPTOELECTRONICAL PROPERTIES OF INDIUM SULFIDE THIN FILMS PREPARED BY SPRAY PYROLYSIS  
M. Calixto-Rodríguez, A. Tiburcio-Silver\*, and A. Sanchez-Juarez, Centro de Investigación en Energía, UNAM Apto. Postal 34, 62580 Temixco, Mor. Mexico, \*Instituto Tecnológico de Toluca, SEP
- O/PI.05** BARRIER FORMATION AND CHANGES OF IT PARAMETERS DURING THE OXIDE LAYER GROWTH PROCESS ON THE SURFACE OF INDIUM MONOSELENIDE  
S.I. Drapak, S.V. Gavryluk, Z.D. KovalyukFrantsevich Institute of Materials Science Problems, the National Academy of Sciences of Ukraine, Chernivtsi Department, 5 Iryna Vilde Str., Chernivtsi, 58001, Ukraine
- O/PI.06** GROWTH AND CHARACTERIZATION OF ITO THIN FILMS DEPOSITED ON PET SUBSTRATES  
Jaehyeong Lee, Hakkee Jung, School of Electronics and Information Engineering, Kunsan National University, Junsin Yi, School of Information and Communications Engineering, Sungkyunkwan University, Korea
- O/PI.07** MATERIAL ANALYSIS OF PVD GROWN INDIUM SULFIDE FOR  $\text{Cu}(\text{In,Ga})\text{Se}_2$  ABSORBERS  
S. Gall, S. Harel, N. Barreau, J.C. Bernède, J. Kessler, LPSE University of Nantes, France
- O/PI.08** P- TYPE COPPER (I) IODIDE AS HETEROJUNCTION PARTNER FOR  $\text{CuInTe}$  OBSERVED BY TEM, SPV, XPS, AND ERDA TECHNIQUES  
B.R. Sankapal, A. Ennaoui, Th. Dittich, W. Böhne\* and M.Ch. Lux-Steiner, Division Solar Energy Research (SE2), \*Division Structure and Dynamic (SF4), Hahn-Meitner-Institut, Glienicke Strasse 100, 14109 Berlin, Germany
- O/PI.09** COMPARISON OF  $\text{CdS}$  FILMS DEPOSITED FROM CHEMICAL BATHS CONTAINING DIFFERENT DOPING IMPURITIES  
M. Altosaar, K. Ernits, J. Hiie, M. Danilson, J. Krustok, L. Kaupmees, T. Varema, J. Raudoja, E. Mellikov, Tallinn Technical University, Ehitajate tee 5, 19086 Tallinn, Estonia
- O/PI.10** STUDY OF THE ELECTRODEPOSITION OF  $\text{In}_2\text{S}_3$  THIN FILMS  
B. Asenjo, A.M. Chaparro, M.T. Gutiérrez, J. Herrero, C. Maffiotte, CIEMAT, Madrid, Spain
- O/PI.11** PREPARATION OF NANOCRYSTALLINE ZINC SULFIDE BY A NEW CHEMICAL BATH DEPOSITION ROUTE FOR  $\text{CuInS}_2$  SUPERSTRATE THIN FILM SOLAR CELL  
S.D. Sartale, A. Ennaoui and M. Lux-Steiner, Department of Heterogeneous Material Systems (SE2), Hahn-Meitner-Institut, Glienicke Strasse 100, 14109 Berlin, Germany
- O/PI.12** CHEMICAL AND ELECTRONIC PROPERTIES OF ZNO SURFACES IN DEPENDENCE ON THE DEPOSITION PARAMETERS  
Frank Säuberlich, Andreas Klein, Surface Science Division, Materials Science Department, Darmstadt University of Technology, Petersenstr. 23, 64287 Darmstadt, Germany
- O/PI.13** EFFECTS OF THIOUREA CONCENTRATION ON  $\text{CdS}$  THIN FILMS GROWN BY CHEMICAL BATH DEPOSITION FOR  $\text{CdTe}$  SOLAR CELLS\*.  
Rogelio Mendoza-Pérez(a), Guillermo Santana-Rodríguez(b), Jorge Sastre-Hernández(a), Gerardo Contreras-Puente(a), Arturo Morales-Acevedo(c), Aime Arias-Carbajal(b) and Osvaldo Vigil-Galan(b), (a)Escuela Superior de Física y Matemáticas del I.P.N.; Edificio 9, U.P.A.L.M., 07738 México D.F., (b)Instituto de Materiales y Reactivos, U. de la Habana, Cd. de la Habana, C.P. 10400, Cuba, (c)CINVESTAV-IPN, Depto. de Ingeniería Eléctrica, Av. IPN 2508, 07360 México D.F.
- O/PI.14** PROPERTIES OF BANDGAP MODIFIED  $\text{Zn}_{1-x}\text{Mg}_x\text{O}$  TRANSPARENT CONDUCTING FILMS  
K. Matsubara, H. Shibata, A. Yamada, H. Tampo, S. Ishizuka, K. Sakurai, P. Fons, K. Iwata and S. Niki, National Institutes of Advanced Industrial Science and Technology (AIST), Japan

- O/PI.15** AN INVESTIGATION INTO THE INFLUENCE OF VARIOUS METALORGANIC SOURCES ON THE QUALITY OF MOVPE-GROWN CuGaS<sub>2</sub>  
M.S. Branch(a), P.R. Berndt(a), A.W.R. Leitch(a), J. Weber(b), J.R. Botha(a), (a)University of Port Elizabeth, South Africa, (b)Institute for Low Temperature Physics, University of Technology, Dresden, Germany
- O/PI.16** COMPARISON OF CDS FILMS DEPOSITED BY TWO TECHNIQUES: EFFECTS ON CdTe SOLAR CELL  
Jaehyeong Lee, Hakkee Jung, School of Electronics and Information Engineering, Kunsan National University, Junsin Yi, School of Information and Communications Engineering, Sungkyunkwan University, Korea
- O/PI.17** STABILITY BEHAVIOUR OF Cd-FREE CU(IN,GA)SE<sub>2</sub> SOLAR MODULES WITH ALD In<sub>2</sub>S<sub>3</sub> BUFFER LAYER  
S. Spiering, D. Hariskos, S. Schröder, M. Powalla, Zentrum für Sonnenenergie- und Wasserstoff-Forschung (ZSW) Baden-Württemberg, Industriestrasse 6, 70565 Stuttgart, Germany
- O/PI.18** ON THE PHOTOVOLTAIC EFFECT IN ITO-CdS-Cd<sub>1-x</sub>Zn<sub>x</sub>Te-NI HETEROSTRUCTURES  
P. Gashin(a), I.I.Rusu(b), Iuliana Caraman(b), Iulia Salaoru(c), G.I.Rusu(c), (a)State University of Moldova, Faculty of Physics, Kishinau 2009, Moldova, (b)University of Bacau, Physics Department, 700506 Bacau, Romania, (c)“Al.I.Cuza” University, Faculty of Physics, 700506, Iassy, Romania
- O/PI.19** REDUCTION OF IMPURITY INCORPORATION IN ZnO THIN FILMS FOR PHOTOVOLTAIC DEVICES GROWN BY REACTIVE PLASMA DEPOSITION  
K. Iwata(a), H. Sakemi(b), K. Awai(c), T. Yamamoto(d), A. Yamada(a), P. Fons(a), K. Matsubara(a), K. Sakurai(a), H. Tampo(a), S. Ishizuka(a) and S. Niki(a), (a)National Institute of Advanced Industrial Science and Technology (AIST), 1-1-1 Umezono, Tsukuba 305-8568, Japan, (b)Research & Development Center, Sumitomo Heavy Industries Ltd., 5-2 Soubiraki-cyo, Niihama, Ehime 792-8588, Japan, (c)S.H.I. Examination & Inspection Co. Ltd., 5-2 Soubiraki-cyo, Niihama, Ehime 792-8588, Japan, (d)Department of Electronic and Photonic System Engineering, Kochi University of Technology, Tosayamada, Kochi 782-8502, Japan
- O/PI.20** STUDIES OF SPUTTERED ZnTe FILMS AS INTERLAYER FOR THE CdTe THIN FILM SOLAR CELL  
B. Späth, J. Fritsche, A. Klein and W. Jaegermann, Institute of Materials Science, Surface Science Division, Darmstadt University of Technology, Germany
- O/PI.21** UNIFORM LOW RESISTIVITY Ga-DOPED ZnO THIN FILMS PREPARED BY A REACTIVE PLASMA DEPOSITION METHOD ON LARGE SUBSTRATES  
Tetsuya Yamamoto, Kochi University of Technology; Toshiyuki Sakemi, Sumitomo Heavy Industries, Kiyoshi Awai, Sumiju Technical; Sho Shirakata, Ehime University, Kakuya Iwata, AIST; Shigeru Niki, AIST; Tetsuo Ikari, Miyazaki University, Kenji Yoshino, Miyazaki University, Tokio Nakada, Aoyamagakuin University; Tetsuo Yano, AIST, Japan
- O/PI.22** ELECTRODEPOSITION OF ZINC TELLURIDE FILMS ON CUPPER SUBSTRATES  
E. Beltowska-Lehman, P. Ozga, Z. Swiatek, Polish Academy of Sciences, Institute of Metallurgy and Materials Science, Reymonta 25 Str., 30-059 Cracow, Poland, E. Kusior, AGH University of Science and Technology, Mickiewicz Avenue 30, 30-059 Cracow, Poland
- O/PI.23** CuInS<sub>2</sub> THIN FILMS PREPARED BY ILGAR  
N.A. Allsop, H.-J. Muffler, M. Bär, M.C. Lux-Steiner and Ch-H. Fischer Hahn-Meitner-Institut Berlin, Dept. SE2, Glienicker Str. 100, 14109 Berlin, Germany
- O/PI.24** RECOMBINATION MECHANISMS IN THIN-FILM CIGS AND CIS SOLAR CELLS WITH ALD-ZNO BUFFER LAYER  
Ulf Malm, Jonas Malmström, Charlotte Platzer-Björkman and Lars Stolt, Uppsala University, Ångström Solar Center, Sweden
- O/PI.25** CHEMICAL BATH DEPOSITION OF QUANTIZED CdS/CdSe ABSORBERS INSIDE MESOPOROUS, NANOCRYSTALLINE TiO<sub>2</sub> FILMS  
Sven Rühle, Olivia Niitsoo, Shaibal Sarkar, Christophe Pejoux, Gary Hodes and David Cahen, Weizmann Institute of Science, Dept. of Materials and Interfaces, Rehovot 76100, Israel
- O/PI.26** METAL CONTACTS TO CdTe AND ZnTe  
D. Kraft, B. Späth, J. Fritsche, A. Klein, W. Jaegermann, Surface Science Division, Materials Science Department, Darmstadt University of Technology, Petersenstrasse 23, 64287 Darmstadt, Germany
- O/PI.27** SXPS INVESTIGATION OF THE CdS CBD PROCESS AND THE Cd PARTIAL ELECTROLYTE TREATMENT OF CIGS ABSORBERS  
R. Hunger, T. Schulmeyer, M. Lebedev, A. Klein, W. Jaegermann, Darmstadt University of Technology, Surface Science Division, 64287 Darmstadt, Germany, K. Sakurai, S. Niki, AIST, Thin Film Solar Cells Group, Tsukuba 305-8568 Japan
- O/PI.28** TRANSPARENT CONDUCTORS AND BUFFER LAYERS FOR CdTe SOLAR CELLS  
C.S. Ferekides, R. Mamazza, U. Balasubramanian and D.L. Morel, University of South Florida, Tampa, USA
- O/PI.29** OXIDATION OF CUGASE<sub>2</sub> CRYSTALS AND THIN FILMS STUDIED BY ELECTRON PARAMAGNETIC RESONANCE AND X-RAY PHOTOELECTRON SPECTROSCOPY  
R. Würz, A. Meeder, D. Fuertes Marrón, Th. Schedel-Niedrig, I. Laueremann, M. Vogel, M. Ch. Lux-Steiner, Hahn-Meitner-Institut, Abteilung SE2, Glienicker Strasse 100, 14109 Berlin, Germany, K. Lips, Hahn-Meitner-Institut, Abteilung SE1, Kekuléstrasse 5, 12489 Berlin, Germany, H. Bluhm, Fritz-Haber-Institut der Max Planck Gesellschaft, Faradayweg 4-6, 14195 Berlin, Germany

- O/PI.30** CADMIUM SULFIDE/INDIUM SULFIDE AS A MODEL SYSTEM FOR UNDERSTANDING INDIUM RELATED CHEMICAL REACTIVITY AT CIGS/CDS INTERFACES: XPS, ELECTRICAL AND IN-SITU LUMINESCENCE INVESTIGATIONS  
B. Canava, I. Gerard, A. Etcheberry, IREM-Université de Versailles-Saint Quentin, 45 ave des Etats Unis, 78035 Versailles Cedex, France  
 J.F. Guillemoles, D. Lincot, Ecole Nationale Supérieure de Chimie de Paris, 11 rue Pierre et Marie Curie, 75231 Paris Cedex 05, France
- O/PI.31** A PRELIMINARY STUDY OF CdS FOR SOLAR CELLS USING COMBINED TEM AND CATHODOLUMINESCENCE  
 K. Mam, D.P. Halliday, K. Durose, Dept. Physics, University of Durham, South Road, Durham DH1 3LE, U.K.
- O/PI.32** STRUCTURAL AND CHEMICAL INVESTIGATIONS OF CBD- AND PVD-CdS BUFFER LAYERS AND INTERFACES IN Cu(In,Ga)Se<sub>2</sub>-BASED THIN-FILM SOLAR CELLS  
D. Abou-Ras, G. Kosterz, ETH Zürich, Institute of Applied Physics, 8093 Zürich, Switzerland, A. Romeo, D. Rudmann, A.N. Tiwari\*, ETH Zürich, Thin Film Physics Group, Laboratory for Solid State Physics, Technoparkstrasse 1, 8005 Zürich, Switzerland, \*also at: Centre for Renewable Energy Systems and Technology, Department of Electronic and Electrical Engineering, Loughborough University, Leicestershire LE11 3TU, U.K.
- O/PI.33** EFFECTS OF BIAS VOLTAGE ON THE PROPERTIES OF ITO FILMS PREPARED ON POLYMER SUBSTRATES  
Jaehyeong Lee, Hakkee Jung, School of Electronics and Information Engineering, Kunsan National University, Donggun Lim, Keajoon Yang, Department of Electronic Engineering, Chungju National University, Junsin Yi, School of Information and Communications Engineering, Sungkyunkwan University, Korea
- O/PI.34** HIGH TRANSMITTANCE AND LOW RESISTIVE ZnO:Al FILMS FOR THIN FILM SOLAR CELLS  
Jinsu Yoo, Jeongchul Lee, Seokki Kim, Kyunghoon Yoon, I Jun Park, S. K. Dhungel, Junsin Yi, Korea

15:45

**BREAK**

## Session II: Heterojunctions

Session chairs: Tokio Nakada, Andreas Klein

- O-II.1** 16:00 -Invited- BUFFER LAYERS IN CIGS BASED SOLAR CELLS AND MODULES  
**D. Hariskos**, Zentrum für Sonnenenergie- und Wasserstoff- Forschung (ZSW), Industriestr. 6, 70565 Stuttgart, Germany
- O-II.2** 16:30 RE-ENGINEERING OF CIGS NATURAL SURFACES BY CHEMICAL ETCHING FOR BETTER UNDERSTANDING AND CONTROLLING INTERFACE CHEMISTRY IN HIGH EFFICIENCY CIGS SOLAR CELLS-AN XPS STUDY  
B. Canava, A. Etcheberry, IREM-Université de Versailles-Saint Quentin, 45 ave des Etats Unis, 78035 Versailles Cedex, France, J.F. Guillemoles, D. Lincot, Ecole Nationale Supérieure de Chimie de Paris, 11 rue Pierre et Marie Curie, 75231 Paris Cedex 05, France
- O-II.3** 16:45 IN-LINE DEPOSITION OF In<sub>x</sub>S<sub>y</sub> LAYERS FOR EFFICIENT ZnO/In<sub>x</sub>S<sub>y</sub>/-Cu(In,Ga)Se<sub>2</sub> SOLAR CELLS  
A. Strohm(a), T. Schloetzer(a), K. Gebhardt(b), A. Harding(a), H.W. Schock(a), (a)Universität Stuttgart, Institut für Physikalische Elektronik, Pfaffenwaldring 47, 70569 Stuttgart, (b)Institut für Angewandte Physik, Heinrich-Heine-Universität Duesseldorf, Universitaetsstr. 25, 40225 Duesseldorf, Germany
- 17:00 DISCUSSION I  
 Akira Yamada, Dimitri Hariskos, Susanne Siebentritt  
 Is CdS the best material for heterojunctions?

Wednesday, May 26, 2004

Afternoon

14:00

POSTER SESSION II

Absorbers, new materials, novel devices and concepts

Session chair: Daniel Lincot

- O/PII.01** GROWTH OF POLYCRYSTALLINE II-VI CHALCOGENIDE THIN FILMS BY ELECTROCHEMICAL SYNTHESIS  
R. Chandramohan(a), D. Kalyanaraman(b) and T. Mahalingam(c), (a)Department of Physics, Sree Sevugan Annamalai College, Devakottai-630 303, India, (b)Sudharshan Engineering College, Pudukottai, India, (c)Department of Physics, Alagappa University, Karaikudi-630 003, India
- O/PII.02** PHYSICO-CHEMICAL CHARACTERISATION OF Cu(In,Al)Se<sub>2</sub> THIN FILM FOR SOLAR CELLS OBTAINED BY SELENISATION PROCESS  
E. Halgand, J.C. Bernède, S. Marsillac, LPSE FSTN, Université de Nantes, 2 rue de la Houssinière, BP 9220, 44320 Nantes Cedex 3, France
- O/PII.03** STRUCTURE, MORPHOLOGY AND OPTICAL PROPERTIES OF CuInS<sub>2</sub> THIN FILMS PREPARED BY MODULATED FLUX DEPOSITION  
C. Guillén(a), J. Herrero(a), M.T. Gutiérrez(a) and F. Briones(b), (a)Dep. Energías Renovables, CIEMAT, Av. Complutense 22, 28040 Madrid, Spain, (b)Instituto de Microelectrónica de Madrid, CNM-CSIC, Isaac Newton 8, Tres Cantos, 28760 Madrid, Spain
- O/PII.04** FIVE SOURCE PVD FOR THE DEPOSITION OF CIGSS ABSORBER LAYERS  
Mario Gossia(a,b) and William N. Shafarman(a), (a)Institute of Energy Conversion, University of Delaware, 451 Wyoming Road, Newark DE 19716, USA, (b)Institut fuer Festkoerperphysik, Friedrich-Schiller-Universitaet Jena, Max-Wien-Platz 1, 07743 Jena, Germany
- O/PII.05** GROWTH OF BRIDGMAN INGOTS OF CuGa<sub>x</sub>In<sub>1-x</sub>Se<sub>2</sub> FOR P.V. CELLS  
T. Cheung, H. Du, C.H. Champness and I. Shih, Electrical and Computer Engineering Dept., McGill University, 3480 University St., Montreal H3A 2A7, Quebec, Canada
- O/PII.06** Cd<sub>1-x</sub>Zn<sub>x</sub>Te THIN FILMS AND JUNCTIONS  
C.S. Ferekides, G. Sivaraman, S. Subramanian, M. Ramalingam, J. Gaduputi and D.L. Morel, University of South Florida, Department of Electrical Engineering, Clean Energy Research Center, 4202 E. Fowler Ave., Tampa FL 33620, USA
- O/PII.07** SYNTHESIS OF CuInGaSe<sub>2</sub> NANOPARTICLES BY SOLVOTHERMAL ROUTE  
Young-Gab Chun, Ki-Hyun Kim\* and Kyung-Hoon Yoon, Korea Institute of Energy Research, 71-2 Jang-dong, Yusong-gu, Daejeon, 305-343 Korea, \*Dept. of Inorganic Materials Engineering, Kyungpook National University, 1370 Sankyuk-dong, Puk-ku, Deagu, 702-701, Korea
- O/PII.08** PREPARATION AND CHARACTERIZATION OF CuInS<sub>2</sub> THIN FILMS COMPLETELY CONVERTED FROM CuInSe<sub>2</sub> BY SULFURIZATION  
G.P. Liu and B.H. Tseng, Institute of Materials Science and Engineering, National Sun Yat-Sen University, Kaohsiung 804, Taiwan
- O/PII.09** CONTROL OF STRUCTURE OF CdS/CdTe IN PULSE LASER EPITAXY  
I. Stefaniuk(a), A. Blahut(b), M. Kuzma(a), (a)University of Rzeszow, Institute of Physics, Rejtana 16a, 35-959 Rzeszow, Poland, (b)Rzeszow University of Technology, Department of Physics, Wincentego Pola 2, 35-959 Rzeszow, Poland
- O/PII.10** SODIUM INCORPORATION STRATEGIES FOR CIGS GROWTH AT DIFFERENT TEMPERATURES  
D. Rudmann(a), D. Brémaud(a), A.F. da Cunha(b), M. Kaelin(a), H. Zogg(a), A.N. Tiwari(a,c), (a)Thin-Film Physics Group, ETH Zürich, Switzerland, (b)Dep. de Física, Univ. de Aveiro, Portugal, (c)Dept. of Electronic and Electrical Eng., Loughborough Univ., U.K.
- O/PII.11** TWO STAGE GROWTH OF SMOOTH Cu(In,Ga)Se<sub>2</sub>  
J. Schöldström, J. Kessler, M. Edoff, University of Uppsala, Ångström Solar Center, Box 534, 75121 Uppsala, Sweden
- O/PII.12** THE FORMATION OF THIN CdSe LAYERS PREPARED BY THE CHEMICAL REACTION OF CADMIUM FILMS AND SELENIUM VAPOUR  
G. Sáfrán, O. Geszti and G. Radnóczy, Research Institute for Technical Physics and Materials Science, HAS, Konkoly-Thege út 29-33, 1121 Budapest, Hungary
- O/PII.13** THE EFFECT OF SULFUR PRESSURE ON THE DEPTH DISTRIBUTION OF IMPURITIES IN Cu(In,Ga)S<sub>2</sub> FILMS  
R. Kaigawa(a), T. Wada(b), S. Bakehe(c), R. Klenk(c), (a)Department of Electronics and Informatics, Ryukoku University, Seta, Otsu 520-2194, Japan, (b)Department of Materials Chemistry, Ryukoku University, Seta, Otsu 520-2194, Japan, (c)Hahn-Meitner Institut, Abteilung SE2, Glienickestr.100, 14109 Berlin, Germany
- O/PII.14** ELECTRODEPOSITION OF CADMIUM TELLURIDE THIN FILMS ON MO AND TCO/GLASS SUBSTRATES FOR SOLAR CELLS: MATERIAL CHARACTERISATION AND FLUX RECRYSTALLIZATION  
J. Hiie, J. Kois, V. Valdna, Department of Materials Science, and V. Mikli, Tallinn Technical University, Centre for Materials Research, Ehitajate tee 5, 19086 Tallinn, Estonia

- O/PII.15** CRYSTAL QUALITY STUDIES OF CuInS<sub>2</sub> FILMS PREPARED BY SPRAY PYROLYSIS  
I. Oja, A. Katerski, A. Mere, O. Kijatkina, M. Krunks, Department of Materials Science, Tallinn Technical University, Ehitajate 5, Tallinn 19086, Estonia, M. Nanu, A. Goossens, Laboratory for Inorganic Chemistry, Delft University of Technology, Julianalaan 136, 2628 BL Delft, The Netherlands
- O/PII.16** GROWTH STUDIES OF Cu-In-S THIN FILMS USING IN-SITU RAMAN SPECTROSCOPY  
E. Rudigier, R. Scheer, Hahn-Meitner Institute, Dep. SE3, Glienicke Str. 100, 14109 Berlin, Germany and Beatriz Barcones, Alejandro Pérez-Rodríguez, Ingeniería i Materials Electrònics (EME), Departament d'Electrònica, Universitat de Barcelona, Martí Franquès 1, 08028 Barcelona, Spain
- O/PII.17** E-BEAM ABLATION TECHNOLOGY: PROPERTIES OF CIGS LAYERS AND JUNCTIONS ON THEIR BASE  
 Ac. A.M. Andriesh(a), V.I. Verlan(a), L.A. Malahova(b), (a)Center of Optoelectronics of IAP, (b)Institute of Mathematique, Academy of Sciences of Moldova
- O/PII.18** PREPARATION OF CuIn(Se,S)<sub>2</sub> BY MECHANOCHEMICAL PROCESS AND PREPARATION OF THEIR THIN FILS  
T. Wada and H. Kinoshita, Department of Materials Chemistry, Ryukoku University, Seta Otsu 520-2194, Japan
- O/PII.19** RESULTS ON MONOCRYSTALLINE CuInSe<sub>2</sub>-BASED CELLS  
 H. Du, C.H. Champness and I. Shih, Electrical and Computer Engineering Dept., McGill University, 3480 University St., Montreal H3A 2A7, Quebec, Canada
- O/PII.20** FORMATION OF TRANSPARENT AND OHMIC ZnO/MoSe<sub>2</sub>/Cu(In,Ga)Se<sub>2</sub> CONTACTS FOR BIFACIAL Cu(In,Ga)Se<sub>2</sub> SOLAR CELLS  
P.J. Rostan, J. Mattheis, U. Rau, and J.H. Werner, Stuttgart, Germany
- O/PII.21** MATERIALS ISSUES IN VERY THIN FILM CdTe FOR PHOTOVOLTAICS  
S.J.C. Irvine, V. Barrioz, E. Jones, University of Wales, Bangor, U.K.
- O/PII.22** NUMERICAL MODELING OF GRAIN BOUNDARY EFFECTS ON Cu(In,Ga)Se<sub>2</sub> THIN-FILM SOLAR CELLS  
 K. Taretto, U. Rau and J.H. Werner, Institut für Physikalische Elektronik, Pfaffenwaldring 47, 70569 Stuttgart, Germany
- O/PII.23** STUDY OF CHARGE-CARRIER DYNAMIC IN 3D INORGANIC SOLAR CELLS  
Marian Nanu, Joop Schoonman and Albert Goossens, Laboratory for Inorganic Chemistry, Julianalaan 136, 2628 BL Delft, The Netherlands
- O/PII.24** CHEMICAL TREATMENT OF CuInSe<sub>2</sub> MONOGRain POWDER SURFACE  
 M. Kauk, K. Ernits, T. Varema, M. Altosaar, E. Mellikov Tallinn Technical University, Ehitajate tee 5, 19086 Tallinn, Estonia
- O/PII.25** PREPARATION AND CHARACTERIZATION OF TIN SULPHIDE THIN FILMS BY SPRAY PYROLYSIS TECHNIQUE  
 H. Ben Haj Salah, H. Bouzouita and B. Rezig, Laboratoire de Photovoltaïque et Matériaux Semi-conducteurs, Ecole Nationale des Ingénieurs de Tunis (E.N.I.T), BP 37, Belvédère 1002 Tunis, Tunisie
- O/PII.26** FABRICATION OF SnS<sub>2</sub>/SnS HETEROJUNCTION THIN FILM DIODES BY PLASMA ENHANCED CHEMICAL VAPOR DEPOSITION  
A. Sanchez-Juarez(a), A. Tiburcio-Silver(b), and A. Ortiz(c), (a)Centro de Investigación en Energía, UNAM Apto. Postal 34, 62580 Temixco, Mor. Mexico, (b)Instituto Tecnológico de Toluca, SEP, (c)Instituto de Investigaciones en Materiales, UNAM P. O. Box 70-360, 04510 Coyoacan, D.F. Mexico
- O/PII.27** SYNTHESIS AND CHARACTERISTICS OF NANOSTRUCTURED CuInS<sub>2</sub> FILMS  
 Xianghui Hou and Kwang-Leong Choy, School of Mechanical, Materials, Manufacturing Engineering and Management, The University of Nottingham, University Park, Nottingham NG7 2RD, U.K.
- O/PII.28** DEVICE CONFIGURATION AND PROCESSING FOR n-CIS FLEXIBLE SOLAR CELL  
Shalini Menezes, Yan Li, Sharmila J. Menezes InterPhases Research, 166 N. Moorpark Rd, #204, Thousand Oaks CA 91360, USA
- O/PII.29** PHOTOELECTROCHEMICAL WATER SPLITTING FOR HYDROGEN PRODUCTION USING MULTIPLE BANDGAP COMBINATION OF PHOTOVOLTAIC CELL AND THIN-FILM-PHOTOCATALYST  
Neelkanth G. Dhere, Anant H. Jahagirdar and Upendra S. Avachat, Florida Solar Energy Center, University of Central Florida, 1679 Clearlake Road, Cocoa FL 32922, USA
- O/PII.30** EFFECT OF HYDROGEN PLASMA TREATMENT ON THE ELECTRICAL PROPERTIES OF SPUTTERED N-DOPED CUPROUS OXIDE FILMS  
Yang-Ming Lu, Jun-Yuan Chen, Tzuu-Shaang Wey, Ming Hong Lin, Kun Shan University of Technology, Yung-Kang City, Tainan, Taiwan
- O/PII.31** LOW COST CIGS SOLAR CELLS BY PASTE COATING AND SELENIZATION  
M. Kaelin(a), D. Rudmann(a), F. Kurdesau(a), H. Zogg(a), T. Meyer(b), A.N. Tiwari(a,c), (a)Thin-Film Physics Group, ETH Zürich, Switzerland, (b)Solaronix SA, Rue de l'Ouriette 129, 1170 Aubonne, Switzerland, (c)Dept. of Electronic and Electrical Eng., Loughborough Univ., U.K.
- O/PII.32** ELECTRON TRANSPORT IN CuInS<sub>2</sub>-BASED NANOSTRUCTURED SOLAR CELLS  
Catelijne Grasso(a), Marian Nanu(b), Albert Goossens(b) and Marc Burgelman(a), (a)University of Gent (UGent), St. Pietersnieuwstraat 41, 9000 Gent, Belgium, (b)Delft University of Technology (TUD), Laboratory of Inorganic Chemistry, Julianalaan 136, 2628 BL Delft, The Netherlands

- O/PII.33** ELECTRICAL AND OPTICAL CHARACTERIZATION OF AgInSnS<sub>4</sub> THIN FILMS GROWN BY SPRAY PYROLYSIS  
J.J. Cayente-Romero(a), J.M. Peza-Tapia(a), M.L. Albor- Aguilera(b), L.R. De León- Gutiérrez(a), M. Ortega- López(a),  
(a)Electrical Engineering Department - SEES, CINVESTAV-IPN, 07360 México D.F., (b)E.S.F.M.-I.P.N.,U.P.L.M.,  
Zacatenco, 07738 México D.F.
- O/PII.34** GRAIN AND CRYSTALLITE SIZE IN FeS<sub>2</sub> THIN FILMS  
J.R. Ares\*, A. Pascual, I.J. Ferrer, C. Sánchez. Dpto. de Física de Materiales, C-IV, U.A.M., Cantoblanco, 28049 Madrid,  
Spain, \*Laboratoire de Chimie Metallurgique des Terres Rares, ISCA-CNRS, Rue Henri Dunant 2-8, 94320 Thiais Cedex,  
France
- O/PII.35** SINGLE-STEP LIGHT ASSISTED PATTERNING OF PHOTONIC PROPERTIES OF CHEMICAL-BATH-DEPOSITED  
CDSE NANOCRYSTALLINE FILMS  
M. Šimurda, P. N'mec, F. Trojánek, P. Maly, Charles University in Prague, Ke Karlovu 3, 121 16 Prague 2, Czech Republic,  
T. Miyoshi, K. Kasatani, Yamaguchi University, 2-16-1 Tokiwadai, 755-8611 Ube, Japan

15:45

**BREAK**

### Session III: Widegap and novel devices

Session chairs: Jim Sites, Neelkanth Dhere

- O-III.1** 16:00 -Invited- MATERIAL AND DEVICE ISSUES IN WIDEGAP CHALCOGENIDE SOLAR CELLS  
**S. Niki**, K. Sakurai, S. Ishizuka, K. Matsubara, P. Fons, K. Iwata, H. Tampo and A. Yamada, AIST, 1-1-1  
Umezono, Tsukuba, Ibaraki 305-8568, Japan, T. Baba, Y. Kimura, S. Nakamura and H. Nakanishi Tokyo  
University of Science, 2641 Yamazaki, Noda, Chiba 278-0022, Japan, R.T. Widodo, K. Ohki, K. Fujita, N.  
Terada, Kagoshima University, 1-21-40 Korimoto, Kagoshima, Kagoshima 890-0065, Japan
- O-III.2** 16:30 -Invited- Cu<sub>2</sub>ZnSnS<sub>4</sub> THIN FILM SOLAR CELLS  
**Hironori Katagiri**, Nagaoka National College of Technology, 888 Nishikatakai, Nagaoka, Niigata, 940-  
8532, Japan
- O-III.3** 17:00 -Invited- SEMI-TRANSPARENT AND BIFACIAL CIGS THIN FILM SOLAR CELLS FABRICATED USING  
TRANSPARENT CONDUCTING OXIDE BACK CONTACTS  
**Tokio Nakada**, Takehito Tokado and Daisuke Ohmori, Department of Electrical Engineering and  
Electronics, Aoyama Gakuin University, Kanagawa, Japan
- O-III.4** 17:30 TRANSPARENT HIGH PERFORMANCE CdSe THIN-FILM SOLAR CELLS  
P. Mahawela, S. Jeedigunta, S. Vakkalanka, C.S. Ferekides and D.L. Morel, University of South Florida,  
Tampa, USA
- O-III.5** 17:45 MODELING AND DESIGN OPTIMIZATION OF EXTREMELY-THIN ABSORBER SOLAR CELLS  
K. Taretto and U. Rau, Institut für Physikalische Elektronik, Pfaffenwaldring 47, 70569 Stuttgart, Germany
- O-III.6** 18:00 COMPARATIVE STUDY OF 3D INORGANIC SOLAR CELLS OBTAINED BY AL-CVD AND SPRAY  
PYROLYSIS  
Marian Nanu, Joop Schoonman, and Albert Goossens, Laboratory for Inorganic Chemistry, Faculty of  
Applied Sciences, Delft University of Technology, Julianalaan 136, 2628 BL Delft, The Netherlands

Thursday, May 27, 2004

Morning

Session IV: Heterojunction properties

Session chairs: A. Etcheberry, Jose Herrero

- O-IV.1** 08:30 -Invited- INTERFACE PROPERTIES OF CHALCOGENIDE BASED SOLAR CELLS  
**Andreas Klein**, Darmstadt University of Technology, Institute of Materials Science, Surface Science Division, Petersenstrasse 23, 64287 Darmstadt, Germany
- O-IV.2** 09:00 -Invited- CHALCOGENIDE SOLAR CELLS: CHOOSING THE BUFFER  
**J.R. Sites** and M. Gloeckler, Physics Department, Colorado State University, Fort Collins CO 80523, USA
- O-IV.3** 09:30 CHARACTERIZATION OF INTERFACE-NATURE AND BAND-ALIGNMENT IN CdS/CIGS BI-LAYER STRUCTURE BY PES/IPES  
**N. Terada**, R.T. Widodo, K. Itoh, K. Fujita, T. Okuda and K. Obara, Kagoshima University, 890-0065 Kagoshima, Japan, S. Niki, K. Sakurai, A. Yamada and S. Ishizuka, AIST, 305-8568 Tsukuba, Japan
- O-IV.4** 09:45 DIRECT DETERMINATION OF THE BAND ALIGNMENT AT i-ZnO-CONTAINING INTERFACES IN CU(IN,Ga)(S,SE)<sub>2</sub> THIN FILM SOLAR CELLS  
**G. Storch**, L. Weinhardt, C. Heske, and E. Umbach, Experimentelle Physik II, Universität Würzburg, Am Hubland, D-97074 Würzburg, Germany, and S. Visbeck, T.P. Niesen, and F. Karg, Shell Solar, 81739 München, Germany
- O-IV.5** 10:00 POTENTIAL DISTRIBUTION OF Cu(In,Ga)(S,Se)<sub>2</sub> - SOLAR CELL CROSS-SECTIONS MEASURED BY KELVIN PROBE FORCE MICROSCOPY  
**Th. Glatzel**, H. Steigert, S. Sadewasser, R. Klenk and M.Ch. Lux-Steiner, Hahn-Meitner-Institut, Dept. Solar Energy, Berlin, Germany
- O-IV.6** 10:15 INTERFACE ANALYSIS OF ZnO/CIGSSe AND (Zn,Mg)O/CIGSSe BY SYNCHROTRON-BASED SPECTROSCOPY  
**I. Lauer**, A. Grimm, I. Kötschau, Ch.-H. Fischer, S. Sokoll, R. Klenk, Th. Glatzel, M.Ch. Lux-Steiner, Hahn-Meitner-Institut, Berlin, Germany; L. Weinhardt, G. Storch, O. Fuchs, C. Heske, Exp. Physik II, Universität Würzburg, Germany, C. Jung, W. Gudat, BESSY, Berlin, Germany; T. P. Niesen, S. Visbeck, F. Karg, Shell Solar GmbH, München, Germany
- 10:30 **BREAK**

Session V: Absorber growth and properties

Session chairs: John Kessler, Heinrich Metzner

- O-V.1** 11:00 -Invited- Na IN Cu(In,Ga)Se<sub>2</sub>  
**A. Rockett**, D. Liao, C. Lei, and I. Robertson. Department of Materials Science and Engineering, University of Illinois, 1304 W. Green St., Urbana IL 61801, USA
- O-V.2** 11:30 Cu K-EDGE X-RAY FINE STRUCTURE CHANGES IN CdTe WITH CdCl<sub>2</sub> PROCESSING  
Xiangxin Liu and **A.D. Compaan**, U. of Toledo, Toledo, OH 43606 USA, and Jeff Terry, Department of Biological, Chemical, and Physical Sciences, Illinois Institute of Technology, Chicago IL 60616 and Department of Physics, University of Notre Dame, Notre Dame IN 46556, USA
- O-V.3** 11:45 SUBSTRATE INFLUENCE ON Cu(In,Ga)Se<sub>2</sub> FILM TEXTURE  
**T. Schlenker**, V. Laptev, H.W. Schock, and J.H. Werner, University of Stuttgart, Institute of Physical Electronics, Pfaffenwaldring 47, 70569 Stuttgart, Germany
- O-V.4** 12:00 FORMATION AND CHARACTERISATION OF MoSe<sub>2</sub> IN Cu(In,Ga)Se<sub>2</sub> BASED SOLAR CELLS  
**D. Abou-Ras**, G. Kostorz, ETH Zürich, Institute of Applied Physics, 8093 Zürich, Switzerland, D. Bremaud, M. Kälin, F.V. Kurdesau, A.N. Tiwari\*, ETH Zürich, Thin Film Physics Group, Laboratory for Solid State Physics, Technoparkstrasse 1, 8005 Zürich, Switzerland, M. Döbeli, Paul Scherrer Institute, c/o ETH Zürich, Institute for Particle Physics, 8093 Zürich, Switzerland, \*also at: Centre for Renewable Energy Systems and Technology, Department of Electronic and Electrical Engineering, Loughborough University, Leicestershire, LE11 3TU, UK
- O-V.5** 12:15 ELECTROCHEMICALLY PROCESSED CuInS<sub>2</sub> ABSORBER LAYERS  
**T. Wilhelm**, B. Berenguier, M. Aggour, M. Kanis and H.J. Lewerenz, Division of Solar Energy, Hahn-Meitner-Institut Berlin, Glienicke Str. 100, 14109 Berlin, Germany
- 12:30 **LUNCH**

Thursday, May 27, 2004

Afternoon

14:00

POSTER SESSION III

Characterisation

Session chair: Hans-Werner Schock

- O/PIII.01** PHOTOLUMINESCENCE AND RAMAN SPECTROSCOPY OF POLYCRYSTALLINE AgInTe<sub>2</sub>  
A. Jagomägi, J. Krustok, J. Raudoja, I. Oja, M. Grossberg. Department of Materials Science, Tallinn Technical University, Ehitajate tee 5, Tallinn 19086, Estonia
- O/PIII.02** ION BEAM LUMINESCENCE OF CdS THIN FILM FORMED BY SPRAY PYROLYSIS  
M. Khanlary, IKIU University, Iran, P. Townsend, Sussex University, U.K., B. Ulrich, Bowling Green University, USA
- O/PIII.03** PIEZOELECTRIC PHOTOTHERMAL INVESTIGATION OF PROTON IRRADIATION INDUCED DEFECTS IN CuInSe<sub>2</sub> EPITAXIAL FILMS  
Y. Akaki(a,b), N. Ohroyji(a), A. Fukuyama(a), K. Yoshino(a), S. Kawakita(c), M. Imaizumi(c), S. Niki(d), K. Sakurai(d), S. Ishizuka(d), T. Ohshima(e) and T. Ikari(a), (a)Department of Electrical and Electronic Engineering, Miyazaki University, 1-1 Gakuen-kibanadai, Miyazaki, 889-2192, Japan, (b)Department of Electrical Engineering, Miyakonojo National College of Technology, 473-1 Yoshio, Miyakonojo, Miyazaki, 885-8567, Japan, (c)Office of Research and Development, NASDA Tsukuba Space Center, 2-1-1, Sengen, Ibaraki, 305-8505, Japan, (d)Photonics Research Institute, National Institute of AIST, 1-1-1 Umezono, Tsukuba, Ibaraki, 305-8568, Japan, (e)Japan Atomic Energy Research Institute, 1233 Watanuki, Takasaki, Gumma 370-1292, Japan.
- O/PIII.04** THE INFLUENCE OF THERMAL ANNEALING IN PRESENCE OF CdCl<sub>2</sub> ON THE ELECTROPHYSICAL PROPERTIES OF THE CdS/CdTe SOLAR CELLS  
Petru Gasin(a), Mihail Caraman(b), Sergiu Vatavu(c) (a)Moldova State University, Faculty of Physics (b)Moldova State University, Faculty of Physics, Chair of Physics (c)Moldova State University, Faculty of Physics, Scientific Research Lab "Semiconductor Physics" Moldova State University, Faculty of Physics, 60 A. Mateevici str., MD-2009, Chisinau Moldova
- O/PIII.05** STRUCTURAL PROPERTIES AND QUALITY OF THE PHOTOEXCITED STATE IN Cu(InGa)Se<sub>2</sub> SOLAR CELL ABSORBERS WITH LATERAL SUBMICRON RESOLUTION  
G.H. Bauer(a), L. Gütay(a), R. Kniese(b), (a)Institute of Physics, Faculty of Mathematics and Natural Sciences, Carl von Ossietzky University, 26111 Oldenburg, Germany, (b)Center for Solar Energy and Hydrogen Research ZSW, 70569 Stuttgart, Germany
- O/PIII.06** PHOTOLUMINESCENCE STUDY OF POLYCRYSTALLINE CdS/CdTe THIN FILM SOLAR CELLS  
Jochen Van Gheluwe, Jorg Versluys, Paul Clauws, Dirk Poelman Ghent University, Department of Solid State Sciences, Gent, Belgium
- O/PIII.07** Y LUMINESCENCE IN POLYCRYSTALLINE CdTe FILMS GROWN BY CSVT-TECHNIQUE  
M. Cárdenas-García, J. Aguilar-Hernández, G. Contreras-Puente, Escuela Superior de Física y Matemáticas, Instituto Politécnico Nacional, Edificio No. 9 U.P.A.L.M., 07738 México D.F., México
- O/PIII.08** CIGS J-V DISTORTION IN THE ABSENCE OF BLUE PHOTONS  
A.O. Pudov and J.R. Sites, Colorado State Univ., Ft. Collins CO, USA, M.A. Contreras, National Renewable Energy Laboratory, Golden CO, USA, T. Nakada, Aoyama Gakuin Univ., Kanagawa, Japan, H.-W. Schock, Inst. Physikalische Elektronik, Univ. Stuttgart, Germany
- O/PIII.09** EFFICIENCY LIMITATIONS FOR WIDE BAND GAP CHALCOPYRITE SOLAR CELLS  
M. Gloeckler and J.R. Sites, Colorado State University, Department of Physics, Fort Collins CO 80523, USA
- O/PIII.10** THE INFLUENCE OF IMPURITIES ON GROWTH AND PROPERTIES OF CIGS USING TWO-STEP PROCESSING  
H. Sankaranarayanan, V. Mohanakrishnaswamy, S. Pethe, C.S. Ferekides and D.L. Morel, University of South Florida, Tampa FL USA
- O/PIII.11** TWINNING IN CdHgTe, CdTe AND HgTe  
I.V. Kurilo(a), I.O. Rudyi(a), M.S. Fruginiskij(a), I.S. Virt(b), M. Kuzma(c), P. Sagan(c), J. Zawislak(c), (a)Lviv Polytechnic National University, 12 Bandera str., 79646 Lviv, Ukraine, (b)Drohobych State Pedagogical University 24 Franko str., 82100 Drohobych, Ukraine, (c)Institute of Physics, University of Rzeszow, Rejtana 16A, 35-959 Rzeszow, Poland
- O/PIII.12** LATTICE DISTORTION AROUND IMPURITY ATOMS AS DOPANTS IN CdTe  
H. Haas, E. Holub-Krappe, H.-E. Mahnke, HMI Berlin GmbH, 14109 Berlin, Germany, V. Koteski, N. Novakovic, VINCA Institute of Nuclear Science, POB 522, 11001 Belgrade, Serbia, P. Fochuk, B. Hahlovsky, University of Chernivtsi, 274012 Chernivtsi, Ukraine
- O/PIII.13** SURFACE STUDY OF CIGS FILMS CLEANED BY PHYSICAL TREATMENTS  
R.T. Widodo, N. Terada, K. Itoh, K. Ohki, T. Okuda and K. Obara, Kagoshima University, 890-0065 Kagoshima, Japan, S. Niki, K. Sakurai, A. Yamada and S. Ishizuka, AIST, 305-8568 Tsukuba, Japan
- O/PIII.14** EVOLUTION OF THE DEFECT SYSTEM IN PHOTOEXCITED CADMIUM TELLURIDE  
A.B. Smimov, R.K. Savkina, V. Lashkaryov Institute of Semiconductor Physics of NASU, pr. Nauki 45, 03028 Kiev, Ukraine

- O/PIII.15** TEMPERATURE DEPENDENCE OF TIME-RESOLVED PHOTOLUMINESCENCE OF BOUND EXCITONS IN CuInS<sub>2</sub> CRYSTALS  
Kazuki Wakita, Kazuhito Nishi, Yoshihiko Ohta and Takashi Onishi, Department of Physics and Electronics, Graduate School of Engineering, Osaka Prefecture University, Japan
- O/PIII.16** PHOTOLUMINESCENCE STUDIES OF Cu(In,Ga)Se<sub>2</sub>  
N. Rega, A. Zajogin, S. Siebentritt, M.Ch. Lux-Steiner, Hahn-Meitner-Institut, 14109 Berlin, Germany, M.J. Romero, National Renewable Energy Laboratory, Golden CO 80401, USA
- O/PIII.17** PEEM-CHARACTERISATION OF KCN-ETCHED CuInS<sub>2</sub>-SURFACES  
K. Müller, Y. Burkov, A. Goryachko, D. Schmeisser, Brandenburgische Technische Universität Cottbus, Angewandte Physik-Sensorik, 03013 Cottbus, P.O. Box 101344, Germany
- O/PIII.18** STUDY OF Cu-Se AND In-Se BOND-LENGTH DISTRIBUTIONS IN CuInSe<sub>2</sub>, Cu<sub>2</sub>In<sub>4</sub>Se<sub>7</sub> AND CuIn<sub>3</sub>Se<sub>5</sub>  
J.M. Merino, M. León, Departamento de Física Aplicada C-XII, Universidad Autónoma de Madrid, 28049 Madrid, Spain, S. Díaz-Moreno, Diamond Light Source, Rutherford Appleton Laboratory, Chilton, Didcot, Oxfordshire OX11, 0QX, U.K., G. Subías, Instituto de Ciencia de Materiales de Aragón, CSIC-Univ. de Zaragoza, 50009 Zaragoza, Spain
- O/PIII.19** KINETICS OF DONOR ACCEPTOR PAIR RECOMBINATION IN Cu-DEFICIENT CuGaSe<sub>2</sub>  
T. Riemann and J. Christen, Institute of Experimental Physics, Otto-von-Guericke-University, PO Box 4120, 39016 Magdeburg, Germany, M. Dworzak and A. Hoffmann, Institute of Solid State Physics, Technical University Berlin, Hardenbergstr. 36, 10632 Berlin, Germany, S. Siebentritt and I. Beckers, Hahn-Meitner-Institute, Glienicke Str. 100, 14109 Berlin, Germany
- O/PIII.20** LAPLACE-DLTS ANALYSIS OF THE MINORITY CARRIER TRAPS IN THE Cu(In,Ga)Se<sub>2</sub> -BASED SOLAR CELLS  
P. Zabierowski, Faculty of Physics, Warsaw University of Technology, Koszykowa 75, 00-662 Warsaw, Poland, U. Rau, Institute of Physical Electronics, University of Stuttgart, Pfaffenwaldring 47, 70569 Stuttgart, Germany, M. Bodegard, Angstrom Solar Center, Uppsala University, P.O. Box 534, 75121 Uppsala, Sweden
- O/PIII.21** TEMPERATURE DEPENDENCE OF THE DIODE IDEALITY FACTOR IN CuInS<sub>2</sub> - ON - Cu- TAPE SOLAR CELLS  
Johan Verschraegen and Marc Burgelman, Gent University, Electronics and Information Systems, Pietersnieuwstraat 41, 9000 Gent, Belgium, Jürgen Penndorf, IST, Im Technologiepark 7, 15236 Frankfurt/Oder, Germany
- O/PIII.22** EFFECT OF PROTON IRRADIATION ON CUGASE2 EPITAXIAL FILMS  
T. Rissom, S. Siebentritt, M. Ch. Lux-Steiner, Hahn-Meitner-Institut Berlin, Glienickestr. 100, 14109 Berlin, Germany
- O/PIII.23** LASER-LIGHT SCATTERING AS AN IN-SITU PROCESS CONTROL FOR PVD DEPOSITION OF Cu(In,Ga)Se<sub>2</sub> THIN FILMS  
A. Neisser, C.A. Kaufmann, R. Klenk, R. Scheer, Hahn-Meitner-Institut Berlin GmbH, Glienickestrasse 100, 14109 Berlin, Germany
- O/PIII.24** NON-EXPONENTIAL CAPACITANCE TRANSIENTS OBSERVED WITH DEEP LEVEL TRANSIENT SPECTROSCOPY ON CuInGaSe<sub>2</sub> SOLAR CELLS  
E. Schlenker(a), V. Mertens(a), M. Köntges(b), R. Reineke-Koch(b), J. Parisi(a), (a)University of Oldenburg, Institute of Physics, Department of Energy and Semiconductor Research, 26111 Oldenburg, Germany, (b)Institute for Solar Energy Research Hameln-Emmerthal (ISFH), Am Ohrberg 1, 31860 Emmerthal, Germany
- O/PIII.25** RHEED STUDY OF CdTe AND CdHgTe THIN FILMS GROWN ON Si BY PULSE LASER DEPOSITION  
P. Sagan(a), G. Wisz(a), M. Bester(a), I.O. Rudyj(b), I.V. Kurilo(b) I.E. Lopatynskij(b), I.S. Virt.(c, d), M. Kuzma(a), (a)Institute of Physics, University of Rzeszow, Rejtana 16A, 35-959 Rzeszow, Poland, (b)State University, "Lviv Polytechnic", Bandera 12, 90646 Lviv, Ukraine, (c)Section of Experimental Physics, Pedagogical University, Franco 24, 82-100 Drogobych, Ukraine, (d)Institute of Biotechnology, University of Rzeszow, Rejtana 16A, 35-959 Rzeszow, Poland
- O/PIII.26** COMPENSATING DONORS IN THE Cu(In, Ga)Se<sub>2</sub> ABSORBERS OF SOLAR CELLS  
M. Igalson, Faculty of Physics, Warsaw University of Technology, Koszykowa 75, 00-662 Warszawa, Poland and M. Bodegård, Ångström Solar Center, Uppsala University, P.O. Box 534, 751 21 Uppsala, Sweden
- O/PIII.27** DETERMINATION OF THE QUALITY OF CUINS2-BASED SOLAR CELLS COMBINING RAMAN AND PHOTOLUMINESCENCE SEPCTROSCOPY  
E. Rudigier, T. Enzenhofer, R. Scheer, Hahn-Meitner Institute, Dep. SE3, Glienicke Str. 100, 14109 Berlin, Germany
- O/PIII.28** MORPHOLOGY AND STRUCTURE OF THIN EPITAXIAL Cu(In,Ga)S<sub>2</sub> FILMS ON Si SUBSTRATES  
Th. Hahn, H. Metzner, U. Reislöhner, J. Cieslak, J. Eberhardt, M. Müller and W. Witthuhn, Friedrich-Schiller-Universität Jena, Institut für Festkörperphysik, Max-Wien-Platz 1, 07743 Jena, Germany.
- O/PIII.29** EPITAXIAL CuInS<sub>2</sub> ON Si(111) USING DI-TERT-BUTYL-DISULFIDE AS A SULPHUR PRECURSOR  
C. Lehmann, W. Calvet, T. Plake and C. Pettenkofer, Hahn-Meitner-Institut, Glienicke Str. 100, 14109 Berlin, Germany
- O/PIII.30** STRUCTURAL PECULIARITIES OF CCSVT-GROWN CuGaSe<sub>2</sub> THIN FILMS  
M. Rusu, S.Doka, R. Würz, A. Meeder, P. Schubert-Bischoff, N. Pfänder, E. Strub, J. Röhrich, W. Bohne, Th. Schedel-Niedrig, M.Ch. Lux-Steiner, Hahn-Meitner-Institut, Glienicke Str. 100, 14109 Berlin, Germany

- O/PIII.31** THERMAL CHARACTERIZATION AND DETERMINATION OF RECOMBINATION PARAMETERS IN CdTe FILMS ON GLASS SUBSTRATE BY USING OPEN PHOTOACOUSTIC CELL TECHNIQUE  
M.A. Gonzalez-Trujillo(a), A. Cruz-Orea(b), M. de L. Albor-Aguilera(c), F. de L. Castillo-Alvarado(c), (a)Departamento de Ciencias Básicas, Escuela Superior de Computo, IPN, Miguel Othon de Mendizabal s/n, lindavista, CP 07738 Mexico DF, México, (b)Departamento de Física, Centro de Investigación y Estudios Avanzados del IPN, Av. IPN No. 2508, Col. Sn. Pedro Zacatenco, CP 07360 México DF, México, (c)Departamento de Física, Escuela Superior de Física y Matemáticas, IPN, Edificio 9, Unidad Profesional "Adolfo López Mateos", CP 07738 México DF, México.
- O/PIII.32** IN-SITU AND IN-DEPTH RESOLVED EX-SITU CHARACTERISATION OF THERMALLY INDUCED RECRYSTALLISATION OF  $\text{CuInS}_2$  POLYCRYSTALLINE THIN FILMS FOR SOLAR CELL DEVICES: OBSERVATION OF POLYMORPHIC TRANSFORMATIONS  
B. Barcones, A. Pérez-Rodríguez, L. Calvo-Barrio, A. Romano-Rodríguez, J.R. Morante, Universitat de Barcelona, C/Marti Franqués 1, 08028 Barcelona, Spain, E. Rudigier, I. Luck, J. Djordjevic, R. Scheer, Hahn Meitner Institute, Glienicker Strasse 100, 14109 Berlin, Germany
- O/PIII.33** ON CORRELATION OF CdS AND CdSe VALENCE BAND PARAMETERS  
P.P. Horley, V.V. Gorley, P.M. Gorley, Yuri Fedkovych Chernivtsi National University, 2 Kotsyubynsky Str., 58012 Chernivtsi, Ukraine and J. Gonzalez-Hernandez, Yu.V. Vorobiev, CINVESTAV Unidad Queretaro, Libramiento Norponiente 2000, Fracc. Real de Juriquilla, 76230 Queretaro QRO, Mexico
- O/PIII.34** EFFECT OF  $\text{CdCl}_2$  ACTIVATION ON THE IMPURITY DISTRIBUTION IN CdTe/CdS SOLAR CELL STRUCTURES  
M. Emziane(a), K. Durose(a), N. Romeo(b), D.P. Halliday(a) (a)Department of Physics, University of Durham, South Road, Durham, DH1 3LE, U.K., (b)INFN, Department of Physics, University of Parma, Parco Area delle Scienze 7a, 43100 Parma, Italy.
- O/PIII.35**  $\text{CuGaSe}_2$  (001) Surface A (1x4) Reconstruction  
Th. Deniozou, N. Esser, Institute of Spectrochemistry and Applied Spectroscopy, Albert-Einstein-Str. 9, 12489 Berlin-Adlershof, Germany, S. Siebentritt, R.Hunger and M. Lux-Steiner, Hahn-Meitner-Institut Berlin, Glienickerstr. 100, 14109 Berlin, Germany, P. Vogt, Institute of Solid State Physics, TU Berlin, Hardenbergstr. 36, 10623 Berlin, Germany
- O/PIII.36** PHOTOSENSITIVITY OF HETEROJUNCTIONS MANUFACTURED BY A METHOD OF ELECTROCHEMICAL DEPOSITION  
A.Sh. Abdinov, H.M. Mamedov, H.A. Hasanov, Baku State University, Z. Khalilov st. 23, 370148 Baku, Azerbaijan Republic
- O/PIII.37** RELAXATION AND RADIATIVE RECOMBINATION DYNAMICS IN  $\text{CuGaSe}_2$   
A. Hoffmann and M. Dworzak, Institute of Solid State Physics, Technical University Berlin, Hardenbergstr. 36, 10632 Berlin, Germany, T. Riemann and J. Christen, Institute of Experimental Physics, Otto-von-Guericke-University, PO Box 4120, 39016 Magdeburg, Germany, S. Siebentritt and I. Beckers, Hahn-Meitner-Institute, Glienicker Str. 100, 14109 Berlin, Germany

15:45

**BREAK**

## Session VI: Characterisation

Session chairs: Gottfried Bauer, Marc Burgelman

- O-VI.1** 16:00 SOLAR CELLS BASED ON CCSVT-GROWN  $\text{CuGaSe}_2$  - ABSORBER AND DEVICE PROPERTIES  
M. Rusu, S. Wiesner, S. Doka, C.A. Kaufmann, N. Grigorieva\*, Th. Schedel-Niedrig, M.Ch. Lux-Steiner, Hahn-Meitner-Institut, Glienicker Str. 100, D-14109 Berlin, Germany, \*Research Institute of Physics, St. Petersburg State University, Ulyanovskaya Str. 1, 198504 St. Petersburg, Russia
- O-VI.2** 16:15 STRUCTURAL TRANSITION DURING DEPOSITION OF CIGS FILMS WITH HIGH GALLIUM CONTENT  
K. Sakurai, S. Ishizuka, A. Yamada, K. Matsubara, K. Iwata, P. Fons, T. Kojima, S.Niki, AIST EEL, Tsukuba, 305-8568 Japan, S. Nakamura, Y. Kimura, T. Baba, S. Nakanishi, TUS Elec. Eng., Noda, 278-8510 Japan
- O-VI.3** 16:30 ELECTRONIC TRANSPORT MECHANISMS IN  $\text{CuGaSe}_2$   
Susanne Siebentritt, Thorsten Rissom, Martha Lux-Steiner Hahn-Meitner-Institut, Glienicker Str. 100, 14109 Berlin, Germany
- O-VI.4** 16:45 THE DETERMINATION OF CARRIER MOBILITIES IN CIGS PHOTOVOLTAIC DEVICES USING HIGH FREQUENCY ADMITTANCE MEASUREMENTS  
JinWoo Lee and J. David Cohen, Materials Science Institute, University of Oregon, Eugene OR 97403, USA, William N. Shafarman, Institute of Energy Conversion, University of Delaware, Newark DE 19716, USA
- 17:00 DISCUSSION II  
Rommel Noufi, Lars Stolt, Al Compaan, Shigeru Niki  
Chalcogenide thin film solar cells in 2020

Friday, May 28, 2004

Morning

Session VII: Defects and polycrystallinity

Session chairs: Margret Igalson, J. David Cohen

- O-VII.1** 08:30 -Invited- ANALYSIS OF CdTe AND CIGS SOLAR CELLS IN RELATION TO MATERIALS ISSUES  
**M. Burgelman**, J. Verschraegen, S. Degrave and P. Nollet, University of Gent, Dept. ELIS, Pietersnieuwstraat 41, 9000 Gent, Belgium
- O-VII.2** 09:00 DEFECT RELATED PHOTOLUMINESCENCE OF EPITAXIAL CuInS<sub>2</sub>  
J. Eberhardt, **H. Metzner**, J. Cieslak, Th. Hahn, U. Reislöhner, A. Dietz, and W. Witthuhn, Institut für Festkörperphysik, Universität Jena, Max-Wien-Platz 1, 07743 Jena, Germany, F. Hudert and R. Goldhahn, Institut für Physik, Technische Universität Ilmenau, PF 100565, 98684 Ilmenau, Germany.
- O-VII.3** 09:15 QUASI-FERMI LEVEL SPLITTING AND IDENTIFICATION OF RECOMBINATION LOSSES IN Cu(In,Ga)Se<sub>2</sub> THIN FILMS VERSUS OPTICAL BAND GAP FROM ROOM TEMPERATURE LUMINESCENCE  
**G.H. Bauer**(a), R. Brüggemann(a), S. Tardon(a), S. Vignoli(b), R. Kniese(c), (a)Institute of Physics, Carl von Ossietzky University, 26111 Oldenburg, Germany, (b)Lab. PMCN (CNRS UMR), Université Claude Bernard Lyon1, 69622 Villeurbanne Cedex, France, (c)Center for Solar Energy and Hydrogen Research ZSW, 70569 Stuttgart, Germany
- O-VII.4** 09:30 -Invited- RECENT PROGRESS TOWARD UNDERSTANDING GRAIN BOUNDARIES IN Cu(In,Ga)Se<sub>2</sub>  
**M.J. Romero**, C.-S. Jiang, R. Noufi and M.M. Al-Jassim, National Renewable Energy Laboratory (NREL), 1617 Cole Boulevard, Golden CO 80401-3393, USA
- O-VII.5** 10:00 -Invited- HOW CAN POLYCRYSTALLINE CdTe/CdS OUTPERFORM THEIR SINGLE CRYSTAL ANALOGUES?  
**Iris Visoly-Fisher**, Sidney R. Cohen and David Cahen, Weizmann Institute of Science, Rehovot, Israel, Arie Ruzin Dept. of Physical Electronics, Tel Aviv University, Tel Aviv, Israel
- 10:30 **BREAK**

Session chairs: Uwe Rau, Ken Durose

- O-VII.6** 11:00 WHY DO CIGS-BASED SOLAR CELLS HAVE SUPERIOR PERFORMANCE? INSIGHT INTO THE PROPERTIES OF GRAIN BOUNDARIES AND THE SURFACE AS INFLUENCED BY GROWTH DYNAMICS  
**R. Noufi**, M.J. Romero, C.-S. Jiang, Y. Yan, J. Abu-shama, and K. Ramanathan, National Renewable Energy Laboratory (NREL), 1617 Cole Blvd., Golden, CO 80401-3393, USA
- O-VII.7** 11:15 -Invited- EFFICIENCY LIMITS OF CIGS SOLAR CELLS  
**J.H. Werner**, Universität Stuttgart, Institut für Physikalische Elektronik, Pfaffenwaldring 47, 70563 Stuttgart, Germany
- 11:45 DISCUSSION III  
David Cahen, Angus Rockett  
Are grain boundaries in chalcogenides unique?
- 12:45 **LUNCH**

Friday, May 28, 2004

Afternoon

- 14:00 SYMPOSIUM SUMMARY