

# Literaturverzeichnis

- [1] M. HARTMANN, M. SCHMIDT, A. JASENEK, and H. W. SCHOCK. Flexible and Light Weight Substrates for Cu(In,Ga)Se<sub>2</sub> Solar Cells and Modules. *Proc. IEEE PVSEC*, p. 638 (2001)
- [2] A. N. TIWARI, M. KREJCI, F. J. HAUG, and H. ZOGG. Cu(In,Ga)<sub>x</sub>Se<sub>y</sub> Epitaxial Layers and Polycrystalline Solar Cells. *Proc. SPIE - The International Society for Optical Engineering*, p. 1227 (2000)
- [3] A. BODEN, D. BRÄUNIG, J. KLEAR, F. H. KARG, and B. HÖSSELBARTH. Proton-Irradiation of Cu(In,Ga)Se<sub>2</sub> and CuInS<sub>2</sub> Thin Film Solar Cells. *Proc. 28th IEEE PVSEC* (2000)
- [4] A. JASENEK, T. HAHN, M. SCHMIDT, K. WEINERT, M. WIMBOR, G. H. K. ORGASSA, M. HARTMANN, H. W. SCHOCK, U. RAU, J. H. WERNER, B. SCHATTAT, S. KRAFT, K. H. SCHMID, W. BOLSE, G. LAROCHE, A. ROBBEN, and K. BOGUS. Stability of Cu(In,Ga)Se<sub>2</sub> thin film solar cells under 1 MeV electron radiation. *Proc. 16th European PVSEC* (2000)
- [5] W. SHOCKLEY and H. QUEISSER. Detailed Balance Limit of Efficiency of *pn*-Junction Solar Cells. *J. Appl. Phys.*, 31, p. 510 (1961)
- [6] H. J. LEWERENZ and H. JUNGBLUT. Photovoltaik (Springer-Verlag Berlin, 1995)
- [7] V. NADENAU, D. HARIKOS, and H. W. SCHOCK. CuGaSe<sub>2</sub> Based Thin Film Solar Cells with Improved Performance. *Proc. 14th European PVSEC*, p. 1250 (1997)
- [8] M. CONTRERAS, B. EGAAS, K. RAMANATHAN, J. HILTNER, A. SWARZTLANDER, F. HASSOON, and R. NOUFI. Progress Towards 20% Efficiency in Cu(In,Ga)Se<sub>2</sub> Polycrystalline Thin Film Solar Cells. *Progress in Photovoltaics*, 7, p. 331 (1999)
- [9] E. PARTHÉ. Crystal Chemistry of Tetrahedral Structures (Gordon and Breach, Science Publishers, New York, London, 1964)
- [10] A. BAUKNECHT. CuGaSe<sub>2</sub> für die Anwendung in der Photovoltaik Metallorganische Gasphasenepitaxie und optische Charakterisierung. Ph.D. thesis, Freie Universität Berlin (1999)
- [11] N. SHIBATA, A. OHKI, S. ZEMBUTSU, and A. KATSUI. Thermoelastic Strain in ZnSe Films Grown on GaAs by Metalorganic Vapour Phase Epitaxy. *Jap. J. Appl. Phys.*, 4, p. L487 (1988)

- [12] LANDOLT-BÖRNSTEIN. Semiconductors-Physics of Groupe IV Elements and III-V Compounds, vol. 17a (Springer, Berlin, 1982)
- [13] LANDOLT-BÖRNSTEIN. Semiconductors-Physics of Ternary Compounds, vol. 17h (Springer, Berlin, 1985)
- [14] J. C. MIKKELSEN. Ternary Phase Relations of the Chalkopyrite Compound CuGaSe<sub>2</sub>. *J. Electr. Mat.*, 10, p. 541 (1981)
- [15] H. NEUMANN. Vacancy Formation Enthalpies in A<sup>I</sup>B<sup>III</sup>C<sub>2</sub><sup>VI</sup> Chalkopyrite Semiconductors. *Crystal Res. & Technol.*, 18, p. 901 (1983)
- [16] A. ZUNGER, S. ZHANG, and S. WEI. Revisiting the Defect Physics in CuInSe<sub>2</sub> and CuGaSe<sub>2</sub>. *Proc. 26th IEEE PVSEC*, p. 313 (1997)
- [17] A. BAUKNECHT, S. SIEBENTRITT, A. GERHARDT, W. HARNEIT, J. A. S. BREHME, S. RUSHWORTH, and M. C. LUX-STEINER. Defects in CuGaSe<sub>2</sub> Thin Films Grown by MOCVD. *Thin Solid Films*, 361-362, p. 426 (2000)
- [18] S. B. ZHANG, S. H. WEI, and A. ZUNGER. Stabilization of Ternary Compounds Via Ordered Defect Arrays of Defect Pairs. *Phys. Rev. Lett.*, 78, p. 4059 (1997)
- [19] L. CHERNYAK, K. GARTSMAN, D. CAHEN, and O. M. STAFSUDD. Electronic Effects of Ion Mobility in Semiconductors: Semionic Behaviour of CuInSe<sub>2</sub>. *J. Phys. Chem. Solids*, 56, p. 1165 (1995)
- [20] A. KLEIN and W. JAEGERMANN. Fermi-Level-Dependent Defect Formation in Cu-Chalkopyrite Semiconductors. *Appl. Phys. Lett.*, 74, p. 2283 (1999)
- [21] A. KLEIN and W. JAEGERMANN. Fermi-Level-Dependent Defect Formation at Cu(In,Ga)Se<sub>2</sub> Interface. *Appl. Sur. Sci.*, 166, p. 508 (00). Puffer
- [22] A. KLEIN, J. FRITSCHKE, W. JÄGERMANN, J. H. SCHÖN, C. KLOC, and E. BUCHER. Fermi-level Dependent Defect Formation at Cu(In,Ga)Se<sub>2</sub> Interfaces. *Appl. Sur. Sci.*, 166, p. 508 (2000)
- [23] W. WALUKIEWICZ. Mechanism of Fermi-Level Stabilisation in Semiconductors. *Phys. Rev. B*, 37, p. 4760 (1988)
- [24] W. WALUKIEWICZ. Fermi Level Dependent Native Defect Formation: Consequences for Metal-Semiconductor and Semiconductor-Semiconductor Interfaces. *J. Vac. Sci. Technol. B*, 6, p. 1257 (1988)
- [25] R. HERBERHOLZ, V. NADENAU, U. RÜHLE, C. KÖBLE, H. SCHOCK, and B. DIMMLER. Prospects of Wide-Gap Chalkopyrites for Thin Film Photovoltaic Modules. *Solar Energy Materials and Solar Cells*, 49, p. 227 (1997)
- [26] J. H. SCHÖN, J. OESTREICH, O. SCHENKER, H. RIAZI-NEJAD, M. KLENK, N. FABRE, E. ARUSHANOV, and E. BUCHER. *n*-Type Conduction in Ge-Doped CuGaSe<sub>2</sub>. *Appl. Phys. Lett.*, 75, pp. 2969 (1999)

- [27] U. RAU, M. SCHMITT, F. ENGELHARDT, O. SEIFERT, J. PARISI, W. RIEDL, J. RIMMASCH, and F. KARG. Impact of Na and S Incorporation on the Electronic Transport Mechanisms of Cu(In,Ga)Se<sub>2</sub> Solar Cells. *Solid State Com.*, 107, pp. 59 (1998)
- [28] C. HESKE, R. FINK, E. UMBACH, W. RIEDEL, and F. KARG. Na-Induced Effects Ont the Electronic Structure and Composition of Cu(In,Ga)Se<sub>2</sub> Thin Film Surfaces. *Appl. Phys. Lett.*, 68, p. 3431 (1996)
- [29] Y. L. SOO, S. H. Y. H. KAO, S. K. DEB, K. RAMANATHAN, and T. TAKIZAWA. Migration of Constituent Atoms and Interface Morphology in a Heterojunction Between CdS and CuInSe<sub>2</sub> Single Crystals. *J. Appl. Phys.*, 86, p. 6052 (1999)
- [30] T. SUGIYAMA, S. CHAISITSAK, A. YAMADA, M. Y. KUDRIAVTSEV, A. GODINES, A. VILLEGAS, and R. ASOMOZA. Formation of pn Homojunction in Cu(In,Ga)Se<sub>2</sub> Thin Film Solar Cells by Zn Doping. *Jap. J. Appl. Phys.*, 39, p. 4816 (2000)
- [31] C. HESKE, D. EICH, R. FINK, E. UMBACH, T. VAN BUUREN, C. BOSTEDT, L. J. TERMINELLO, S. KAKAR, M. M. GRUSH, T. A. CALLCOTT, F. J. HIMPEL, D. L. EDERER, R. C. C. PERERA, W. RIEDL, and F. KARG. Observation of Intermixing at the Buried CdS/Cu(In,Ga)Se<sub>2</sub> Thin Film Solar Cell Heterojunction. *Appl. Phys. Lett.*, 74, p. 1451 (1999)
- [32] T. WADA, S. HAYASHI, Y. HASHIMOTO, S. NISHIWAKI, T. NEGAMI, and M. NISHITANI. High Efficiency Cu(In,Ga)Se<sub>2</sub> (CIGS) Solar Cells with Improved CIGS Surface. *Proc. 2nd WCPEC*, p. 403 (1998)
- [33] K. RAMANATHAN, H. WIESNER, S. ASHER, D. NILES, J. KEANE, M. A. CONTRERAS, and R. NOUFI. High Efficiency Cu(In,Ga)Se<sub>2</sub> Thin Film Solar Cells Without Intermediate Buffer Layers. *Proc. 2nd WCPEC* (1998)
- [34] V. NADENAU, D. HARISKOS, H. W. SCHOCK, M. KREJCI, F. J. HAUG, A. N. TIWARI, H. ZOGG, and G. KOSTORZ. Microstructural Study of CdS/CuGaSe<sub>2</sub> Interfacial Region in CuGaSe<sub>2</sub> Thin Film Solar Cells. *J. Appl. Phys.*, 85, p. 534 (1999)
- [35] J. L. SHAY and J. H. WERNICK. Ternary Chalkopyrite Semiconductors: Growth, Electronic Properties, and Applications (Pergamon Press, Oxford, New York, 1975)
- [36] S. SHIRAKATA and S. CHICHIBU. Photorefectance of Cu-Based I-III-VI<sub>2</sub> Heteroepitaxial Layers Grown by Metalorganic Vapor Deposition. *J. Appl. Phys.*, 79, p. 2043 (1996)
- [37] J. I. PANKOVE. Optical Processes in Semiconductors (Dover Publication, New York, 1975)
- [38] P.Y.YU and M. CARDONA. Optical Processes in Semiconductors (Springer Verlag, Berlin, 1996)
- [39] A. BAUKNECHT, S. SIEBENTRITT, J. ALBERT, and M. C. LUX-STEINER. Radiativ Recombination Via Intrinsic Defects in Cu<sub>x</sub>Ga<sub>y</sub>Se<sub>2</sub>. *J. Appl. Phys.*, 89, p. 4391 (2001)

- [40] A. BAUKNECHT, S. SIEBENTRITT, J. ALBERT, Y. TOMM, and M. C. LUX-STEINER. Excitonic Photoluminescence from CuGaS<sub>2</sub> Single Crystals and Epitaxial Layers: Temperature-dependence of the Band Gap Energy. *J. J. App. Phys.*, 39, p. 322 (2000)
- [41] J. R. ELLIOTT. Intensity and Optical Absorption by Excitons. *Phys. Rev.*, 108, p. 1384 (1957)
- [42] D. J. THOMAS, J. J. HOPFIELD, and W. M. AUGUSTYNIAK. Kinetics of Radiativ Recombination at Randomly Distributed Donors and Acceptors. *Phys. Rev.*, 140, p. 202 (1965)
- [43] F. J. RAMÍERZ and C. RINCÓN. Polarized Micro-Raman Spectra in CuGaSe<sub>2</sub>. *Solid State Com.*, 84, p. 551 (1992)
- [44] G. MASSÉ, N. LAHLOU, and N. YAMAMOTO. Edge Emission of CuGaSe<sub>2</sub>. *J. Appl. Phys.*, 51, p. 4981 (1980)
- [45] M. SUSAKI, T. MIYAUCHI, H. HORINAKA, and N. YAMAMOTO. Photoluminescence Properties of CuGaSe<sub>2</sub> Grown by Iodine Vapour Transport. *J. Appl. Phys.*, 17, pp. 1555 (1978). PL
- [46] J. SCHÖN and E. BUCHER. Comparison of Point Defects in CuInSe<sub>2</sub> and CuGaSe<sub>2</sub> Single Crystals. *Solar Energy Materials and Solar Cells*, 57, pp. 229 (1999)
- [47] J. KRUSTOK, J. RAUDOJA, and J. H. SCHÖN. Photoluminescence Properties of Ge-Impanted CuGaSe<sub>2</sub> Crystals. *Phys. Stat. Sol. (a)*, 178, pp. 805 (2000). PL
- [48] B. I. SHKLOVSKII and A. L. EFROS. Electronic Properties of Doped Semiconductors (Springer, Berlin, 1984)
- [49] A. GERHARD, W. HARNEIT, S. BREHME, A. BAUKNECHT, U. FIEDELER, M. C. LUX-STEINER, and S. SIEBENTRITT. Acceptor Activation Energies in Epitaxial CuGaSe<sub>2</sub> Grown by MOVPE. *Thin Solid Films*, 387, p. 67 (2001)
- [50] A. GERHARD. Elektrische Defektspektroskopie an CuGaSe<sub>2</sub> und verwandten Halbleiterdünnschichten. Ph.D. thesis, Freie Universität Berlin (2000)
- [51] R. MÁRQUEZ and C. RINCÓN. Defect Physics of Ternary Chalcopyrit Semiconductors. *Material Letters*, 40, p. 66 (1999)
- [52] S. M. SZE. Physics of Semiconductor Devices (John Wiley & Sons New York, 2.Auflage, 1981)
- [53] A. JÄGER-WALDAU, H. J. MUFFLER, R. KLENK, M. KIRSCH, C. KELCH, and M. C. LUX-STEINER. Gallium Doped ZnO for Thin Film Solar Cells. *Inst. Phys. Conf. Ser.*, 162, p. 565 (1999)
- [54] E. H. RHODERICK, W. R. FRENZLEY, and M. SHAW. Properties of Junction and Barriers. In: T. S. MOSS and C. HILSUM (Editors), Device Physics, Vol 4., p. 4 (Elsevier Science Publisher, 1993)

- [55] LANDOLT-BÖRNSTEIN. Semiconductors-Physics of II-VI Compounds, vol. 17b (Springer, Berlin, 1982)
- [56] M. E. ÖZSAN, D. R. JOHNSON, M. SADEGHI, D. S. AN L. M. PETER, M. FOURLONG, G. GOODLET, A. SHINGLETON, D. LINCOT, B. MOKILI, and J. VEDEL. Optical and Electrical Characterisation of Chemically Deposited Cadmium Sulfid Thin Films. *Proc. 1st WCPEC*, p. 327 (1994)
- [57] C. D. LOKHANDE, P. PATIL, A. ENNAOUI, and H. TRIBUTSCH. Chemical Bath ZnSe Thin Films: Deposition and Characterisation. *Appl. Sur. Sci.*, 123/124, p. 294 (1998)
- [58] A. ENNAOUI, U. BLISKE, and M. C. LUX-STEINER. 13.7% Efficient Zn(Se,OH)<sub>x</sub>/Cu(In,Ga)(S,Se)<sub>2</sub> Thin Film Solar Cells. *Prog. Photovolt. Res. Appl*, 6, p. 447 (1998)
- [59] A. RUMBERG, C. SOMMERHALTER, M. TOPLAK, A. JÄGER-WALDAU, and M. LUX-STEINER. ZnSe Thin Films Grown by Chemical Vapour Deposition For Application as Buffer Layer in CIGSS Solar Cells. *Thin Solid Films*, 361-362, p. 172 (2000)
- [60] T. NAKADA, K. FURUMI, and A. KUNIOKA. High-Efficiency Cadmium- Free Cu(In,Ga)Se<sub>2</sub> Thin Film Solar Cells with Chemical Deposited ZnS Buffer Layers. *IEEE Trans. Elec. Dev.*, 46, pp. 2093 (1999)
- [61] A. NIEMEGERES and M. BURGELMAN. Numerical Modelling of Ac-Characteristics of CdTe and CIS Solar Cells. *Proc. 25th PVSEC*, p. 901 (1996)
- [62] V. NADENAU, D. BRAUNGER, D. HARISKOS, and H. W. SCHOCK. Characterisation and Optimization of CuGaSe<sub>2</sub>/CdS/ZnO Heterojunctions. *Proc. ICTMC-11, Salford*, p. 955 (1997)
- [63] A. BAUKNECHT, U. BLIESKE, T. KAMPSCHULTE, J. ALBERT, H. SEHNERT, M. C. LUX-STEINER, A. KLEIN, and W. JAEGERMANN. Band Offsets at the ZnSe/CuGaSe<sub>2</sub> (001) Heterointerface. *Appl. Phys. Lett.*, 74, p. 1099 (1999)
- [64] M. RUCKH, D. SCHMID, and H. W. SCHOCK. Photoemission Studies of the ZnO/CdS Interface. *J. Appl. Phys.*, 76, p. 5945 (1994)
- [65] G. B. TURNER, R. J. SCHWARZ, and J. L. GRAY. Band Discontinuity and Bulk Vs. Interface Recombination in CdS/CuInSe<sub>2</sub> Solar Cells. *Proc. 20th IEEE PVSEC*, p. 1457 (1988)
- [66] J. GUTOWSKY, N. PRESSER, and G. KUDLEK. Optical Properties of ZnSe Epilayers and Films. *Phys. Stat. Sol. (a)*, 120, p. 11 (1990)
- [67] W. SHOCKLEY and W. T. READ. Statistics of the Recombination of Holes and Electrons. *Phys. Rev.*, 87, p. 835 (1952)
- [68] V. NADENAU, U. RAU, A. JASENEK, and H. SCHOCK. Electronic Properties of CuGaSe<sub>2</sub>-Based Heterojunction Solar Cells Part I. Transport Analysis. *J. Appl. Phys.*, 87, pp. 584 (2000)

- [69] R. KLENK. Characterisation and Modelling of Chalkopyrit Solar Cells. *Thin Solid Films*, 387, p. 135 (2001)
- [70] M. TOPIČ, F. SMOLE, and J. FURLAN. Examination of Blocking Current-Voltage Behaviour Through Defect Chalkopyrit Layer in ZnO/CdS/Cu(In,Ga)(S,Se)<sub>2</sub>/Mo Solar Cells. *Solar Energy Materials and Solar Cells*, 49, p. 311 (1997)
- [71] W. SHOCKLEY. The Theory of *pn*-Junctions in Semiconductors and *pn*-Junction Transistors. *Bell Syst. Tech. J.*, 28, p. 435 (1949)
- [72] T. WALTER, R. HERBERHOLZ, C. MÜLLER, and H. SCHOCK. Defect Distribution an Metastability in Chalkopyrite Semiconductors. *Solid State Phenomena*, 51-52, p. 309 (1996)
- [73] S. TOBER. Herstellung und Charakterisierung von Dünnschicht-Solarzellen Auf der Basis von CuGaSe<sub>2</sub> und CuInSe<sub>2</sub>. Master's thesis, Freie Universität Berlin (1999)
- [74] U. RAU, A. JASENEK, R. HERBERHOLZ, H. W. SCHOCK, J. F. GUILLMOLES, D. LINCOT, and L. KRONIK. The Inherent Stability of Cu(In,Ga)Se<sub>2</sub>-Based Solar Cells. *Proc. 2nd WC-PEC*, p. 428 (1998)
- [75] R. KLENK. Polykristalline CuGaSe<sub>2</sub>-Dünnschichten für die Photovoltaik Herstellung und Charakterisierung von Absorbern und Heterübergängen. Ph.D. thesis, Universität Stuttgart (1993)
- [76] N. MEYER, T. DYLLA, D. FISCHER, A. JÄGER-WALDAU, and M. C. LUX-STEINER. Solar Cells Based on HCVD Grown CuGaSe<sub>2</sub> Absorbers with High Open-Circuit Voltages. *Proc. 16th Europeen PVSEC* (2000)
- [77] G. B. STRINGFELLOW. Organometallic Vapour Phase Epitaxy - Theory and Practice (Academic Press, London, 1989)
- [78] W. RICHTER. Physics of Metal Organic Vapour Deposition. In: H. P. GROSSE (Editor), *Festkörperprobleme XXVI*, p. 313 (Vieweg, Braunschweig, 1986)
- [79] T. KAMPSCHULTE. MOCVD Von ZnSe für Sperrkontakte in Heterosolarzellen auf der Basis von Chalkopyrit. Ph.D. thesis, Freie Universität Berlin (1998)
- [80] W. EISELE, A. ENNAOUI, P. SCHUBERT-BISCHOFF, M. GIERSIG, C. PETTENKOFER, J. KRAUSER, M. C. LUX-STEINER, S. ZWEIGART, and F. KARG. XPS, TEM and NRA Investigations of Zn(Se,OH)/Zn(OH)<sub>2</sub> Films on Cu(In,Ga)(S, Se)<sub>2</sub> Substrats for Highly Efficient Solar Cells. *Proc. 28th IEEE PVSEC* (2001)
- [81] T. UNOLD, D. BERKHAHN, B. DIMMLER, and G. H. BAUER. Open Circuit Voltage and Loss Mechanisms in Polycrystalline Cu(In,Ga)Se<sub>2</sub>-Heterodiodes from Photoluminescence Studies. *Proc. 16th Europeen PVSEC* (2000)
- [82] C. WEISSMANTEL and C. HAMANN. Grundlagen der Festkörperphysik (Springer-Verlag Berlin, 1979)

- [83] S. ZOTT. Optische Charakterisierung von CuInSe<sub>2</sub>-Dünnschichten mittels stationärer und zeitaufgelöster Photolumineszenz. Ph.D. thesis, Universität Dresden (1997)
- [84] D. S. ALBIN. Fabrication and Structural , Optical, and Electrical Characterisation of Multi-Source Evaporated Copper Gallium Selenide Polycrystalline Thin Films. Ph.D. thesis, University of Arizona (1989)
- [85] INSPEC. Properties of GaAs (INSPEC, 1990)
- [86] M. SUGIYAMA, H. NAKANISHI, and S. CHICHIBU. Experimental Determination of Valance Band Discontinuities at Cu(Al,Ga)(S,Se)<sub>2</sub>/GaAs (001) Heterointerfaces Using Ultraviolet Photoemission Spectroscopy. *Jap. J. Appl. Phys.*, 40, p. L428 (2001)
- [87] S. WEI and A. ZUNGER. Calculated Natural Band Offsets of All II-IV and III-V Semiconductors: Chemical Trends and the Role of Cation D-Orbitals. *Appl. Phys. Lett.*, 72, p. 2011 (1998)
- [88] C. SOMMERHALTER. Kelvinsondenkraftmikroskopie im Ultrahochvacuum zur Charakterisierung von Halbleiter-Heterodioden auf der Basis von Chalkopyrit. Ph.D. thesis, Freie Universität Berlin (1999)
- [89] P. FONS, S. NIKI, A. YAMADA, and H. OYANAGI. Direct Observation of the Cu<sub>2-x</sub>Se Phase of Cu-Rich Epitaxial CuInSe<sub>2</sub> Grown on GaAs (001). *Jap. J. Appl. Phys.*, 84, p. 6926 (1998)
- [90] R. KLENK and H. SCHOCK. Photocurrent Collection in Thin Film Solar Cells - Calculation and Characterisation for CuGaSe<sub>2</sub>/(Zn,Cd)S. *Proc. 12th European PVSEC*, p. 1588 (1994)
- [91] U. RAU and H. W. SCHOCK. Electronic Properties of Cu(In,Ga)Se<sub>2</sub> Heterojunction Solar-Recent Achievements, Current Understanding, and Future Challenges. *Appl. Phys. A*, 69, pp. 131 (1999)
- [92] R. HERBERHOLZ, M. IGALSON, and H. SCHOCK. Distinction Between Bulk and Interface States in CuInSe<sub>2</sub>/CdS/ZnO by Space Charge Spectroscopy. *J. Appl. Phys.*, 83, pp. 318 (1998). Device
- [93] T. NAKADA and M. MIZUTANI. Improved Efficiency of Cu(In,Ga)Se<sub>2</sub> Thin Film Solar Cells with Chemical Deposited ZnS Buffer Layers by Air-Annealing - Formation of Homojunction by Solid Phase Diffusion. *Proc. 28th IEEE PVSEC* (2000)
- [94] D. SCHMID, M. RUCKH, and H. SCHOCK. Photoemission Studies on Cu(In, Ga)Se<sub>2</sub> Thin Films and Related Binary Selenides. *Appl. Sur. Sci.*, 103, pp. 409 (1996)
- [95] B. CANAVA, J. F. GUILLEMOLES, E. B. YOUSFI, P. COWACHE, H. KERBER, A. LOEFFL, H.-W. SCHOCK, M. POWALLA, D. HARISKOS, and D. LINCOT. Wet Treatment Based Interface Engineering for High Efficiency Cu(In,Ga)Se<sub>2</sub> Solar Cells. *Thin Solid Films*, 361-362, p. 187 (2000)

- [96] K. RAMANATHAN, R. NOUFI, J. GRANATA, and J. W. A. J. KAENE. Prospects for in Situ Junction Formation in CuInSe<sub>2</sub> Based Solar Cells. *Solar Energy Materials and Solar cells*, 55, pp. 15 (1998)
- [97] S. NIKI, I. KIM, P. FONS, H. SHIBATA, A. YAMADA, H. OYANAGI, T. KURAFUJI, S. CHICHIBU, and H. NAKANISHI. Effects of Annealing on CuInSe<sub>2</sub> Films Grown by Molecular Beam Epitaxy. *Solar Energy Materials and Solar Cells*, 49, p. 319 (1997)
- [98] J. H. SCHÖN, H. RIAZI-NEJAD, C. KLOC, F. P. BAUMGARTNER, and E. BUCHER. Photoluminescence Properties of Doped- and Undoped-CuGaSe<sub>2</sub> Single Crystals. *Journal of Luminescence*, 72-74, pp. 118 (1997)
- [99] M. S. TYAGI. Introduction to Semiconductor Materials and Devices (Verlag John Wiley, 1992)
- [100] H. NEUMANN and R. D. TOMLINSON. Relation Between Electrical Properties and Composition in CuInSe<sub>2</sub> Single Crystals. *Solar Cells*, 28, p. 301 (1990)
- [101] H. MATSUSHITA, H. JITSUKAWA, H. SUGANO, T. TAKIZAWA, and S. ENDO. Electrical and Optical Properties of CuGaSe<sub>2</sub> Single Crystals Grown by Solution Method Using CuSe Solvent. *Inst. Phys. Conf. Ser.*, 152, p. 535 (1997)
- [102] J. H. SCHÖN. Extrinsic Doping of CuGaSe<sub>2</sub> Single Crystals. *J. Phys. D: Appl. Phys.*, 33, pp. 286 (2000). CGS
- [103] A. YAMADA, P. FONS, S. NIKI, H. SHIBATA, A. OBARA, Y. MAKITA, and H. OYANAGI. A Shallow State in Molecular Beam Epitaxial Grown CuGaSe<sub>2</sub> Film Detectable by 1.62 eV Photoluminescence. *J. Appl. Phys.*, 81, p. 2794 (1997)
- [104] R. KLENK, R. MAUCH, R. SCHÄFFLER, D. SCHMID, and H. SCHOCK. Progress in CuGaSe<sub>2</sub> Based Thin Film Solar Cells. *Proc. IEEE* 91, p. 1071 (1991)
- [105] D. FISCHER. Eigenschaften Von CuGaSe<sub>2</sub>-Dünnschichten Hergestellt mit Chemischer Gasphasenabscheidung. Ph.D. thesis, Freie Universität Berlin (2000)
- [106] S. NISHIWAKI, N. KOHARA, T. NEGAMI, and T. WADA. MoSe<sub>2</sub> Layer Formation at Cu(In,Ga)Se<sub>2</sub>/Mo Interface in High Efficiency Cu(In<sub>1-x</sub>Ga<sub>x</sub>)Se<sub>2</sub> Solar Cells. *Jap. J. Appl. Phys.*, 37, p. L71 (1998)
- [107] W. ARNDT, H. DITTRICH, and H. W. SCHOCK. CuGaSe<sub>2</sub> Thin Films for Photovoltaic Application. *Thin Solid Films*, 130, p. 209 (1985)
- [108] J. R. SITES. Losses Due to Polycrystallinity in Thin Film Solar Cells. *Solar Energy Materials and Solar cells*, 55, p. 43 (1998)
- [109] V. M. GARCÍA, P. K. NAIR, and M. T. S. NAIR. Copper Selenide Thin Films by Chemical Bath Deposition. *J. Cryst. Growth*, 203, p. 113 (1999)



- [110] M. BURGELMAN, F. ENGELHARDT, J. GUILLEMOLES, R. HERBERHOLZ, M. IGALSON, R. KLENK, M. LAMPERT, T. MEYER, V. NADENAU, A. NIEMEGEERS, J. PARISI, U. RAU, H. SCHOCK, S. M. O. SEIFERT, T. WALTER, and S. ZOTT. Defects in Cu(In,Ga)Se<sub>2</sub> Semiconductors and their Role in Device Performance of Thin-Film Solar Cells. *Prog. Photovolt. Res. Appl.*, 5, p. 121 (1997)
- [111] I. HENGEL. Ladungsträgertransport und Rekombinationsmechanismen in Chalkopyrit-Dünnschichtszellen. Ph.D. thesis, Freie Universität Berlin (2000)
- [112] A. NIEMEGEERS, M. BURGELMAN, R. HERBERHOLZ, U. RAU, D. HARISKOS, and H. W. SCHOCK. Model for Electronic Transport in Cu(In,Ga)Se<sub>2</sub> Solar Cells. *Progress in Photovoltaics*, 6, p. 407 (1998)
- [113] M. SAAD, H. RIAZI, E. BUCHER, and M. C. LUX-STEINER. CuGaSe<sub>2</sub> Solar Cells with 9.7% Power Conversion Efficiency. *Appl. Phys. A*, 62, p. 181 (1996)
- [114] S. SCHULER, S. NISHIWAKI, M. DZIEDZINA, R. KLENK, S. SIEBENTRITT, and M. C. LUX-STEINER. Solar Cells Based on PVD Grown CuGaSe<sub>2</sub> - Absorbers and Device Properties. *Angenommen zur Veröffentlichung in MRS Proceedings*, 668 (2001)
- [115] A. GERHARD:.. Messung von A. Gerhard (2000)
- [116] L. STOLT, J. HEDSTRÖM, J. KESSLER, M. RUCK, K. O. VELTHAUS, and H. W. SCHOCK. ZnO/CdS/CuInSe<sub>2</sub> Thin Film Solar Cells with Improved Performance. *Appl. Phys. Lett.*, 62, p. 597 (1993)
- [117] A. ENNAOUI, S. SIEBENTRITT, M. C. LUX-STEINER, W. RIEDL, and F. KARG. High-Efficiency Cd-Free CIGSS Thin Film Solar Cells with Solution Grown Zinc Compound Buffer Layers. *Solar Energy Materials and Solar Cells*, 67, p. 31 (2001)
- [118] S. SIEBENTRITT:.. Unveröffentliche Messung (2000)