



Publications concerning real-time monitoring of epitaxial growth

In all fields of thin-film technology, the trend persists to develop ever more complex and sophisticated thin-film structures. Conventional post-growth evaluation methods of the thin-film production process are becoming obsolete as the need increases for real-time evaluation already during thin-film growth. This is where LayTec's business vision originates. We supply both the thin-film industry and the respective R&D institutions with reliable, robust and highly competitive real-time sensor products.

When real-time sensors are used for simply fingerprinting specific epitaxial device growth processes, a basic understanding of the underlying physics (solid-state physics, surface science, physics of thin-films and interfaces) is usually not necessary. However, for R&D applications and detailed process failure analysis a more detailed insight into the processes generating the sensor signals is needed. Therefore, a list of publications that can be used for further reading is given below.

Area of Research	Specific Topics		References
sensor physics, sensor design, general reading			1, 2, 3, 4, 6, 38, 42, 49, 50, 52, 90, 110, 172, 173
-			-
Optical properties & in-situ monitoring of	GaAs and related materials	GaAs (001):	12, 13, 14, 15, 16, 17, 18, 48, 57, 58, 88, 92, 96, 102, 112, 114, 121, 125, 130, 136, 137, 141, 144, 145, 169, 175
		GaAs (113):	19, 115, 162
		InGaP:	5, 6, 109
		AlGaInP	44, 91, 107, 111, 144, 147, 156
		AlGaAs/GaAs	53, 91, 107, 156, 162, 172,173
		GaAsN	45, 154, 157
		InGaAs	182, 183, 184, 186, 206
		InGaAsN	167
		InAlAs	207
		InP and related materials	InP:
InGaAsP	77, 206		
InGaAlP	151		



	GaP	GaP:	9, 10, 79
	GaN and related materials	GaN:	9, 11, 43, 74, 78, 80, 94, 97, 98, 100, 101, 134, 143, 168, 178, 179, 180, 181, 200, 201, 205, 209, 211
		AlGaN	51, 106, 117, 142, 181, 208, 211
		InGaN	93, 140, 149, 150, 179
		HVPE growth	117
	Antimonides	GaSb	29, 30, 55, 56, 76, 84, 85, 87, 155, 186, 187, 188, 189, 192, 193
	II-VI materials	ZnSe:	26, 89, 101, 36
	Group IV	Si (001):	27, 81, 86, 137, 185, 191, 200
		Ge (113):	28
Quantum dots		InAs/GaAs(001)	31, 32, 33, 34, 35, 36, 82, 120, 127, 129, 131
		CdSe/ZnSe:	37, 196
Metal surfaces			95
Solid-Liquid interfaces			95
Device applications	General		63, 64
	HBTs		124, 202
	Lasers		40, 46, 91, 209
	VCSELs		47, 66, 67, 68, 145, 2010
	Production		39, 69, 70, 126
Closed-loop control			41
Doping	GaAs		59, 60, 61, 62, 91, 112, 113, 132, 162
Exchange Reactions	As/P		54, 96, 122
ELOG, patterned substrates			81, 138, 152
True Temperature			75, 83, 101, 108
Theory			71, 72, 73, 105
Curvature	InP-based material		99
	GaAs-based materials		158
	III-Nitride on Sapphire		65, 101, 104, 108, 119, 133, 146, 160, 176
	III-Nitride on Si		65, 78, 101, 146, 159, 164, 165, 166, 170, 171, 177, 178, 181, 194, 195



- [1] J.-T. Zettler,
Characterization of epitaxial semiconductor growth by reflectance-anisotropy- spectroscopy and ellipsometry, Progress in Crystal Growth and Characterization of Materials 35, 27 (1997).
- [2] W. Richter and J.-T. Zettler,
Real-Time Analysis of III-V-Semiconductor Epitaxial Growth, Appl. Surface Science 100/101, 465 (1996).
- [3] K. Haberland, O. Hunderi, M. Pristovsek, J.-T. Zettler and W. Richter,
Ellipsometric and Reflectance-Anisotropy Measurements on rotating samples, Thin Solid Films 313/314, 620 (1998).
- [4] J.-T. Zettler, W. Richter, K. Ploska, M. Zorn, J. Rumberg, C. Meyne, and M. Pristovsek,
Real time diagnostics of semiconductor surface modifications by reflectance anisotropy spectroscopy in Semiconductor Characterization - Present Status and Future Needs, edited by W. Bullis, D. Seiler, and A. Diebold (AIP Press, Woodbury, New York, 1996), p. 537.
- [5] M. Zorn, P. Kurpas, A.I. Shkrebtii, B. Junno, A. Bhattacharya, K. Knorr, M. Weyers, L. Samuelson, J.-T. Zettler, and W. Richter,
Correlation of InGaP(001) surface structure during growth and bulk ordering, Phys. Rev. B 60, 8185 (1999).
- [6] M. Zorn, T. Trepk, P. Kurpas, M. Weyers, J.-T. Zettler, and W. Richter,
In-situ monitoring and control of InGaP growth on GaAs in MOVPE, J. Crystal Growth, 195, 223 (1998).
- [7] M. Zorn, T. Trepk, J.-T. Zettler, B. Junno, C. Meyne, K. Knorr, T. Wethkamp, M. Klein, Miller, W. Richter, and L. Samuelson,
On the temperature dependence of the InP(001) bulk and surface dielectric function, Appl. Phys. A 65, (1997). 333-339.
- [8] S. Visbeck, T. Hannappel, M. Zorn, J.-T. Zettler, W. Richter, F. Willig,
Temperature dependence and origin of InP(100) reflectance anisotropy down to 25 K, Phys. Rev. B 63: 245303 (2001) .
- [9] M. Zorn, B. Junno, T. Trepk, S. Bose, L. Samuelson, J.-T. Zettler, W. Richter,
Optical response of reconstructed GaP(001) surfaces, Phys. Rev. B60, 11557(1999).
- [10] L. Töben, T. Hannappel , K. Möller, H.-J. Crawack, C. Pettenkofer, F. Willig,
RDS, LEED and STM of the P-rich and Ga-rich surfaces of GaP(100), Surf. Sci., 494: L755 (2001).
- [11] S. Peters, T. Schmidtling, T. Trepk, U.W. Pohl, J.-T. Zettler, and W. Richter,
In-situ monitoring of GaN metal-organic vapor phase epitaxy by spectroscopic ellipsometry, J. Appl. Phys. 88, 1 (2000).
- [12] J.-T. Zettler, M. Pristovsek, T. Trepk, A. Shkrebtii, E. Steimetz, M. Zorn and W. Richter,
Response of the surface dielectric function to dynamic surface modifications: application of reflectance anisotropy and spectroscopic ellipsometry, Thin Solid Films 313/314, 537 (1998).
- [13] L. Däweritz, K. Stahrenberg, P. Schützendübe, J.-T. Zettler, W. Richter, and K.H. Ploog,
Evolution of short- and long-range order during Si incorporation on GaAs (001) observed by RAS and RHEED during MBE, J. Cryst. Growth 175/176, 310 (1997).



- [14] M. Wassermeier, J. Behrend, J.-T. Zettler, K. Stahrenberg, W. Richter, and K.H. Ploog, **In-situ spectroscopic ellipsometry of GaAs (001) surface reconstructions**, Phys. Rev. B53, 13542 (1996).
- [15] M. Wassermeier, J. Behrend, J.-T. Zettler, K. Stahrenberg, W. Richter, and K.H. Ploog, **In-situ spectroscopic ellipsometry and reflectance difference spectroscopy of GaAs (001) surface reconstructions**, Appl. Surface Science 107, 48 (1996).
- [16] J. Rumberg, J.-T. Zettler, K. Stahrenberg, K. Ploska, W. Richter, L. Däweritz, P. Schützendübe, and M. Wassermeier, **Surface processes responsible for reflectance-anisotropy oscillations during molecular beam epitaxy of GaAs (001)**, Surface Science 337, 103 (1995).
- [17] J.-T. Zettler, T. Wethkamp, M. Zorn, M. Pristovsek, C. Meyne, K. Ploska, and W. Richter, **Growth oscillations with monolayer periodicity monitored by ellipsometry during metalorganic vapour phase epitaxy of GaAs(001)**, Appl. Phys. Lett. 67, 3783 (1995).
- [18] K. Ploska, M. Pristovsek, W. Richter, J. Jönsson, I. Kamiya, and J.-T. Zettler, **Metalorganic vapour phase epitaxial growth on vicinal GaAs (001) surfaces studied by reflectance anisotropy spectroscopy**, phys. stat. sol. (a) 152, 49 (1995).
- [19] M. Pristovsek, H. Menhal, T. Wehnert, J.-T. Zettler, T. Schmidling, N. Esser, W. Richter, C. Setzer, J. Platen, K. Jacobi, **Reconstructions of the GaAs (113) surface**, J. Crystal Growth 195, 1 (1998).
- [20] T. Hannappel, L. Töben, S. Visbeck, K. Möller, F. Willig, **In-situ control of InP(100) and GaP(100) interfaces and characterization with RDS at 20 K**, J. Electr. Mat. 30: 1425 (2001).
- [21] T. Hannappel, L. Töben, S. Visbeck, H.-J. Crawack, C. Pettenkofer, F. Willig, **UPS and 20 K RAS of the P-rich and In-rich surfaces of InP(100)**, Surf. Sci., 470: L1 (2000).
- [22] W.G. Schmidt, N. Esser, A.M. Frisch, P. Vogt, J. Bernholc, F. Bechstedt, M. Zorn, Th. Hannappel, S. Visbeck, F. Willig, W. Richter, **Understanding reflectance anisotropy: Surface-state signatures and bulk-related features in the optical spectrum of InP(001)(2x4)**, Phys. Rev. B 61 (2000) R16335
- [23] Hannappel, T.; Visbeck, S.; Knorr, K.; Mahrt, J.; Zorn, M.; Willig, F, **Preparation of P-rich InP-surfaces via MOCVD and surface characterization in UHV** Appl. Phys. A 69: 427 (1999)
- [24] Esser, N.; Schmidt, W. G.; Bernholc, J.; Frisch, A. M.; Vogt, P.; Zorn, M.; Pristovsek, M.; Richter, W.; Bechstedt, F.; Hannappel T. ; Visbeck, S, **GaP(001) and InP(001): Reflectance anisotropy and surface geometry**, J. Vac. Sci. Technol. B 17: 1691 (1999).
- [25] T. Hannappel, S. Visbeck, M. Zorn, J.-T. Zettler, F. Willig, **Reflectance anisotropy spectra for the transition from the P-rich to the In-rich surface reconstruction of InP(100)**, J. Cryst. Growth, 221: 124 (2000).
- [26] J.-T. Zettler, K. Stahrenberg, W. Richter, H. Wenisch, B. Jobst, and D. Hommel, **Molecular beam epitaxy grown ZnSe studied by reflectance anisotropy spectroscopy and reflection high-energy electron diffraction**, J. Vac. Sci. Technol. B14, 1 (1996).



- [27] J. Zhang, A.K. Lees, A. Schellinger, J.R. Engstrom, M.L. Hsieh, J.-T. Zettler, A.G. Taylor, B.A. Joyce, **Kinetics and dynamics of Si GSMBE studied by reflectance anisotropy spectroscopy**, Surf. Sci. 402-404, 480 (1998).
- [28] S.M. Scholz, K. Jacobi, J.-T. Zettler, and W. Richter, **Reflectance Anisotropy Spectroscopy on the Ge(113) Surface**, Surf. Sci. 359, 205 (1996).
- [29] Z. Kollonitsch, K. Moeller, Ch. Giesen, M. Heuken, F. Willig, T.Hannappel, **In-situ monitored MOVPE growth of undoped and p-doped GaSb(100)**, J. Cryst. Growth, in print.
- [30] K. Möller, Z. Kollonitsch, Ch. Giesen, M. Heuken, F. Willig, T. Hannappel, **Optical in-situ monitoring of MOVPE GaSb(100) film growth**, J. Crystal Growth, 248: 244 (2003).
- [31] E. Steimetz, T. Wehnert, H. Kirmse, F. Poser, J.-T. Zettler, W. Neumann and W. Richter, **Optimizing the growth procedure for InAs quantum dot stacks by optical in-situ techniques**, J. Crystal Growth, 221, 592 (2000).
- [32] E. Steimetz, T. Wehnert, K. Haberland, J.-T. Zettler, and W. Richter, **GaAs Cap Layer Growth and In-Segregation effects on self-assembled InAs-Quantum Dots monitored by optical techniques**, J. Crystal Growth, 195, 223 (1998).
- [33] D.I. Westwood, Z. Sobiesierski, E. Steimetz, J.-T. Zettler, and W. Richter, **On the development of InAs on GaAs(001) as measured by reflectance anisotropy spectroscopy: continuous and islanded films**, Appl. Surf. Sci. 123/124, 347 (1998).
- [34] E. Steimetz, F. Schienle, J.-T. Zettler, W. Richter, **Stranski-Krastanow formation of InAs quantum dots monitored during growth by reflectance anisotropy spectroscopy and spectroscopic ellipsometry**, J. Cryst. Growth 170, 208 (1997).
- [35] E. Steimetz, J.-T. Zettler, F. Schienle, T. Trepk, T. Wethkamp, W. Richter, I. Sieber , **In-situ monitoring of InAs-on-GaAs quantum dot formation in MOVPE by reflectance-anisotropy-spectroscopy and ellipsometry**, Appl. Surface Science 107, 203-211 (1996).
- [36] E. Steimetz, J.-T. Zettler, W. Richter, D.I. Westwood, D.A. Woolf, Z. Sobiesierski, **Optical monitoring of the development of InAs quantum dots on GaAs(001) by reflectance anisotropy spectroscopy**, J. Vac. Sci. Technol. B14, 3058 (1996).
- [37] C. Meyne, U.W. Pohl, J.-T. Zettler, and W. Richter, **Observation of different growth modes in the MOVPE of CdS/ZnS and CdSe/ZnSe by in-situ reflectance anisotropy spectroscopy**, J. Cryst. Growth 184/185, 264 (1998).
- [38] J.-T. Zettler, K. Haberland, M. Zorn, M. Pristovsek, W. Richter, P. Kurpas, and M. Weyers, **Real-Time Monitoring of MOVPE Device Growth by Reflectance-Anisotropy-Spectroscopy and Related Optical Techniques**, J. Crystal Growth, 195, 151 (1998).
- [39] K. Haberland, P. Kurpas, M. Pristovsek, J.-T. Zettler, M. Weyers and W.Richter, **Spectroscopic Process-Sensors in MOVPE-Device-Production**, Appl. Phys. A 68, 309 (1999).
- [40] K. Haberland, A. Bhattacharya, M. Zorn, M. Weyers, J.-T. Zettler, and W. Richter, **MOVPE growth of (Al,Ga)InP-based laser structures monitored by real-time reflectance anisotropy spectroscopy**, Journal of Electron. Mat. 29, 468 (2000).



- [41] T. Trepk, M. Zorn, M. Klein, K. Knorr, A. Krost, J.-T. Zettler, and W. Richter, **Spectroscopic applied for in-situ control of lattice matched growth in MOVPE**, Thin Solid Films 313/314, 496 (1998).
- [42] M. Zorn, J. Jönsson, W. Richter, J.-T. Zettler, and K. Ploska, **Anisotropic Reflectance from Semiconductor Surfaces for in-situ monitoring in epitaxial growth systems**, phys. stat. sol. (a) **152**, 23 (1995).
- [43] H. Hardtdegen, N. Kaluza, R. Schmidt, R. Steins, E.V. Yakovlev, R.A. Talalaev, Yu.N. Makarov, J.-T. Zettler, **MOVPE growth and in-situ characterization of GaN layers on sapphire substrates**, phys. stat. sol. (a) **201**, No. 2, 312-319 (2004).
- [44] C. Watatani, Y. Hanamaki, M. Takemi, K. Ono, Y. Mihashi, T. Nishimura, **In-situ monitoring of AlGaInP by reflectance spectroscopy in metalorganic vapor phase epitaxy**, 2004 International Conference on Indium Phosphide and Related Materials, Conference Proceedings, Kagoshima, Japan (2004).
- [45] F. Poser, V. Hoffmann, S. Weeke, C. Kaspari, M. Pristovsek, W. Richter, **In-situ Investigations of Surface Kinetics During Nitridation and Growth of GaAsN/GaAs**, (presented at ICMOVPE XII-2004, to be published in J. Crystal Growth 2004).
- [46] P. Wolfram, E. Steimetz, W. Ebert, B. Henninger, J.-T. Zettler, **Growth of InGaAsP/InP-laser structures monitored by using RAS techniques**, J. Crystal Growth, **248**, 240-243 (2003).
- [47] R. Roßbach, T. Ballmann, R. Butendeich, H. Schweizer, F. Scholz, M. Jetter, **Red VCSEL for High-Temperature Applications** (presented at ICMOVPE XII-2004, to be published in J. Crystal Growth 2004).
- [48] V. Hoffmann, F. Poser, C. Kaspari, S. Weeke, M. Pristovsek, W. Richter, **Nitrogen-arsenic exchange processes and investigation of the nitrided GaAs surfaces in MOVPE** (presented at ICMOVPE XII-2004, to be published in J. Crystal Growth 2004).
- [49] D.E. Aspnes, **Observation and analysis of epitaxial growth with reflectance-difference spectroscopy**, Mater. Sci. Eng. B 30 (1995) 109
- [50] W. Richter, J.-T. Zettler, **Real-time Analysis of III-V semiconductor epitaxial growth**, Appl. Surf. Sci. 100/101 (1996) 456
- [51] N.A. Sanford, L.H. Robins, A.V. Davydov, A. Shapiro, D.V. Tsvetkov, A.V. Dmitriev, S. Keller, U.K. Mishra, S.P. DenBaars, **Refractive index study of $\text{Al}_x\text{Ga}_{1-x}\text{N}$ films grown on sapphire substrates**, Journal of Applied Physics 94/5 (2003), 2980-2991
- [52] Z. Sobiesiersky, **Aspects of reflectance anisotropy spectroscopy from semiconductor surfaces**, J. Phys.: Condens. Mater. 10 (1998) 1
- [53] K.C. Rose, S.J. Morris, D.I. Westwood, D.A. Woolf, R.H. Williams, W. Richter, **Representative reflectance anisotropy spectra from $\text{Al}(x)\text{Ga}(1-x)\text{As}$ layers ($x=0$ to 1.0) grown on GaAs(001) by molecular beam epitaxy**, Appl. Phys. Lett. 66 (1995) 1930



- [54] J. Jönsson, F. Reinhardt, M. Zorn, K. Ploska, W. Richter, J. Rumberg, **In-situ time resolved monitoring of PH3 induced exchange reactions on GaAs under MOVPE conditions**, Appl. Phys. Lett. 64 (1994) 1998
- [55] C. X. Wang, O. J. Pitts and S. P. Watkins, **Time-resolved reflectance difference spectroscopy study of Sb- and As-terminated InP(100) surfaces**, Journal of Crystal Growth 248 (2003) Pages 259-264
- [56] O. J. Pitts, S. P. Watkins and C. X. Wang, **RDS characterization of GaAsSb and GaSb grown by MOVPE**, Journal of Crystal Growth 248 (2003) Pages 249-253
- [57] F. Reinhardt, J. Jönsson, M. Zorn, W. Richter, K. Ploska, J. Rumberg, P. Kurpas, **Monolayer growth oscillations and surface structure of GaAs(001) during MOVPE growth**, J. Vac. Sci. Technol. B 12 (1994) 2541
- [58] M. Pristovsek, M. Zorn, M. Weyers, **In-situ study of GaAs growth mechanisms using tri-methyl gallium and tri-ethyl gallium precursors in metal-organic vapour phase epitaxy**, Journal of Crystal Growth 262 (2004) 78
- [59] H. Tanaka, E. Colas, I. Kamiya, D. E. Aspnes, R. Bhat, **In-situ determination of free-carrier concentrations by reflectance difference spectroscopy**, Appl. Phys. Lett. 59 (1991) 3443
- [60] M. Pristovsek, B. Han, J.-T. Zettler, W. Richter, **In-situ investigations of GaAs(001) intrinsic carbon p-doping in metal-organic vapour phase epitaxy**, J. Cryst. Growth 221 (2000) 149
- [61] M. Pristovsek, S. Tsukamoto, N. Koguchi, B. Han, K. Haberland, J.-T. Zettler, W. Richter, M. Zorn, M. Weyers, **In-situ Determination of the Carrier Concentration of (001) GaAs by Reflectance Anisotropy Spectroscopy**, physica status solidi (a) 188 (2001) 1423
- [62] M. Pristovsek, S. Tsukamoto, B. Han, J. -T. Zettler and W. Richter, **Influence of the reconstruction of GaAs (001) on the electro-optical bulk properties**, Journal of Crystal Growth 248 (2003) Pages 254-258
- [63] K. Haberland, A. Kaluza, M. Zorn, M. Pristovsek, H. Hardtdegen, M. Weyers, J. -T. Zettler, W. Richter, **Real-time calibration of wafer temperature, growth rate and composition by optical in-situ techniques during Al_xGa_{1-x}As growth in MOVPE**, Journal of Crystal Growth 240 (2002) 87
- [64] M. Zorn, J. Jönsson, A. Krost, W. Richter, J.-Th. Zettler, K. Ploska, and F. Reinhardt, **In-situ Reflectance Anisotropy Studies of Ternary III-V Surfaces and Growth of Heterostructures**, Journal of Crystal Growth 145 (1994) 53
- [65] A. Dadgar, F. Schulze, T. Zettler, K. Haberland, R. Clos, G. Straßburger, J. Bläsing, A. Diez, A. Krost, **In situ measurements of strains and stresses in GaN heteroepitaxy and its impact on growth temperature**, Journal of Crystal Growth 272 (2004) 72-75
- [66] M. Zorn, K. Haberland, A. Knigge, A. Bhattacharya, M. Weyers, J.-T. Zettler, W. Richter, **MOVPE process development for 650 nm VCSELs using optical in-situ techniques**, Journal of Crystal Growth 235 (2002) 25
- [67] M. Zorn, A. Knigge, U. Zeimer, A. Klein, H. Kissel, M. Weyers and G. Tränkle, **MOVPE growth of visible vertical-cavity surface-emitting lasers (VCSELs)**, Journal of Crystal Growth 248 (2003) Pages 186-193



- [68] K. Haberland, M. Zorn, A. Klein, A. Bhattacharya, M. Weyers, J. -T. Zettler, and W. Richter, **In-situ determination of interface roughness in MOVPE-grown visible VCSELs by reflectance spectroscopy**, Journal of Crystal Growth 248 (2003) Pages 194-200
- [69] N. Habets, T. Schmitt, M. Deufel, M. Lünenbürger, M. Heuken, H. Jürgensen, **Real time monitoring of layer growth on planetary reactor by reflectance-anisotropy-spectroscopy**, Thin Solid Films 409 (2002) 43
- [70] T. Bergunde, B. Henninger, M. Lünenbürger, M. Heuken, M. Weyers and J. -T. Zettler, **Automated emissivity corrected wafer-temperature measurement in Aixtrons planetary reactors**, Journal of Crystal Growth 248 (2003) Pages 235-239
- [71] F. Manghi, R. Del Sole, A. Selloni, E. Molinari, **Anisotropy of surface optical properties from first-principle calculations**, Phys. Rev B 41 (1990) 9935
- [72] Y.-C. Chang, D.E. Aspnes, **Theory of dielectric-function anisotropies of (001) GaAs (2x1) surfaces**, Phys. Rev. B 41 (1990) 12002
- [73] A. Lastras-Martinez, R.E. Balderas-Navarro, L.F. Lastras-Martinez, M.A. Vidal, **Model for the linear electro-optic reflectance-difference spectrum of GaAs(001) around E1 and E1+D1**, Phys. Rev. B 59 (1999) 10234
- [74] S. Figge, T. Böttcher, S. Einfeldt, D.Hommel, **In situ and ex situ evaluation of the film coalescence for GaN growth on GaN nucleation layers**, J. of Crystal Growth 221 (2000) 262-266
- [75] T. Bergunde, B.Henninger, M.Lünenbürger, M.Heuken, M.Weyers, J.-T. Zettler **Automated emissivitycorrected wafer-temperature measurement in Aixtron planetary reactors**, J. of Crystal Growth 248 (2003) 235-329
- [76] K. Möller, Z.Kollonitsch, Ch.Giesen, M.Heuken, F.Willig, T.Hannapel, **Optical in situ monitoring of MOVPE GaSb (100) film growth**, J. of Crystal Growth 248 (2003) 244-248
- [77] P. Wolfram, E. Steimetz, W. Ebert, N. Grote, J.-T. Zettler, **Routine Growth of InP Based Device Structures Using Process Calibration with Optical In-situ Techniques**, Journal of Crystal Growth 272 (2004) 118 - 124
- [78] A. Dadgar, F. Schulze, T. Zettler, K. Haberland, R. Clos, G. Straßburger, J. Bläsing, A. Diez, A. Krost, **In-situ measurements of strains and stresses in GaN heteroepitaxy and its impact on growth temperature**, Journal of Crystal Growth 272 (2004) 72 - 75
- [79] T. Hannapel, L. Töben, K. Möller, F. Willig, **In-Situ Monitoring of InP(100) and GaP(100) interfaces and Characterization with RDS at 20 K**, Journal of Electronic Materials, Vol. 30, No. 11, 2001
- [80] N. Kaluza, R. Steins, H. Hardtdegen, H. Lueth, **MOVPE GaN Growth: Determination of Activation Energy Using In-Situ Reflectometry**, Journal of Crystal Growth 272 (2004) 100 – 105,



- [81] A. Strittmatter, T. Trepk, U.W. Pohl, D. Bimberg, J.-T. Zettler, **Optimization of GaN MOVPE Growth on Patterned Si Substrates using Spectroscopic in-situ Reflectance**, Journal of Crystal Growth 272 (2004) 76 - 80
- [82] U. W. Pohl, K. Pötschke, I. Kaiander, J.-T. Zettler, D. Bimberg, **Real-Time Control of Quantum Dot Laser Growth using Reflectance Anisotropy Spectroscopy**, Journal of Crystal Growth 272 (2004) 143 - 147
- [83] R. Steins, N. Kaluza, H. Hardtdegen, M. Zorn, K. Haberland, J.-T. Zettler, **Use of SiC band gap temperature dependence for absolute calibration of emissivity corrected pyrometers in III-Nitride MOVPE**, Journal of Crystal Growth 272 (2004) 81 - 86
- [84] Z. Kollonitsch, K. Möller, H.-J. Schimper, Ch. Giesen, M. Heuken, F. Willig, T. Hannappel, **In situ monitored MOVPE growth of undoped and p-doped GaSb(100)**, J. of Crystal Growth 261 (2004) 289-293
- [85] K. Möller, L. Töben, Z. Kollonitsch, Ch. Giesen, M. Heuken, F. Willig, T. Hannappel, **In-situ monitoring and analysis of GaSb(001) substrate deoxidation**, to be published in J. of Crystal Growth 2004
- [86] T. Hannappel, W.E. McMahon, J.M. Olson, **An RDS, LEED, and STM Study of MOCVD-Prepared Si(100) surfaces**, to be published in J. of Crystal Growth 2004
- [87] Z. Kollonitsch, K. Möller, F. Willig, T. Hannappel, **Reconstructions of MOVPE-prepared group-V-rich GaAsSb(100) surfaces**, Journal of Crystal Growth 272 (2004) 694 - 699
- [88] H. Hardtdegen, M. Pristovsek, H. Menhal, J.-T. Zettler, W. Richter, D. Schmitz, **In situ characterization of GaAs growth in nitrogen atmosphere during MOVPE: a comparison to hydrogen atmosphere**, J. Crystal Growth 195 (1998) 211-216
- [89] C. Meyne, M. Gensch, S. Peters, U.W. Pohl, J.-T. Zettler, W. Richter, **In situ monitoring of ZnS/GaP and ZnSe/GaAs metalorganic vapor phase epitaxy using reflectance anisotropy spectroscopy and spectroscopic ellipsometry**, Thin Solid Films 364 (2000) 12-15
- [90] H. Hardtdegen, M. Zorn, J.-T. Zettler, **Benefits of optical in-situ measurements for the MOVPE of compound semiconductor layers and device structures**, Proceedings of the 12th International Workshop on the Physics of Semiconductor devices, eds. K.N. Bhat and A. DasGupta, Narosa Publishing House, New Delhi, 83 – 89 (2004)
- [91] M. Zorn, M. Weyers, **Application of reflectance anisotropy spectroscopy to laser diode growth in MOVPE**, J. of Crystal Growth 276 (2005) 29-36
- [92] M. Pristovsek, M. Zorn, U. Zeimer, M. Weyers, **Growth of strained GaAsSb layers on GaAs (001) by MOVPE**, J. of Crystal Growth 276 (2005) 347-353
- [93] N.A. Sanford, A. Munkholm, M. R. Krames, A. Shapiro, I. Levin, A. V. Davydov, S. Sayan, L.S.Wielunski, T. E. Madey, **Refractive index and birefringence of $\text{In}_x\text{Ga}_{1-x}\text{N}$ films grown by MOCVD**, Phys. Stat. Sol. 2, No.7, (2005) 2783-2786



- [94] H. Hardtdegen, N. Kaluza, R. Steins, Y.S. Cho, Z. Sofer, M. Zorn, K. Haberland, and J.-T. Zettler, **Use of real time wafer temperature determination for the study of unintentional parameter influences in the MOVPE of nitrides**, Phys. stat. sol. (b) 235, (2003)
- [95] B. Sheridan, D.S. Martin, J.R. Power, S.D. Barrett, C.I. Smith, C.A. Lucas, R.J. Nichols, P. Weightman, **Reflection Anisotropy Spectroscopy: A New Probe for the Solid-Liquid Interface**, Physical Review Letters 85/21, (2000) 4618-4621
- [96] J. Jönsson, F. Reinhardt, K. Ploska, M. Zorn, W. Richter and J.-Th. Zettler **Real time monitoring of PH₃ and AsH₃ induced exchange reactions on GaAs, InGaAs and InP during MOVPE**, Institut für Festkörperphysik der TU Berlin Sekr. PN 6-1, Hardenbergstr.36, 10623 Berlin Germany
- [97] S. Einfeldt, T. Böttcher, S. Figge, D. Hommel, **Thermally induced stress in GaN layers with regard to film coalescence**, Journal of Crystal Growth 230 (2001) 357–360
- [98] D. D. Koleske, M. E. Coltrin, A. A. Allerman, K. C. Cross, C. C. Mitchell, J. J. Figiel, **In situ measurements of GaN nucleation layer decomposition**, Applied Physics letters, Volume 82, No. 8 (2003)
- [99] R. W. Hoffmann, Jr., M. Murphy, J. Cruel, M. Belousov, B. Volf, Ch. Murray, E. A. Armour, **In situ strain control during MOCVD growth of high- quality InP-based long wavelength distributed Bragg reflectors**, Journal of Crystal Growth 261 (2004) 301-308
- [100] D. D. Koleske, A. J. Fischer, A. A. Allerman, C. C. Mitchell, K. C. Cross, S. R. Kurtz, J. J. Figiel, K. W. Fullmer, and W.G. Breiland **Improved brightness of 380 nm GaN light emitting diodes through intentional delay of the nucleation island coalescence**, Applied Physics Letters, Volume 81, No. 11 (2002)
- [101] A. Krost, A. Dadgar, F. Schulze, R. Clos, K. Haberland, T. Zettler, **Heteroepitaxy of GaN on Silicon: In Situ Measurements**, Materials Science Forum Vols. 483-485 (2005) pp. 1051-1056
- [102] S. Tsukamoto, M. Pristovsek, A. Ohtake, B. G. Orr, Gavin R. Bell², T. Ohno, N. Koguchi, **Ga-rich GaAs(0 0 1) surfaces observed by STM during high-temperature annealing in MBE**, Journal of Crystal Growth 251 (2003) 46–50
- [103] M. Pristovsek, M. Zorn, U. Zeimer, M. Weyers, **Growth of strained GaAsSb layers on GaAs (0 0 1) by MOVPE**, Journal of Crystal Growth 276 (2005) 347–353
- [104] S. Raghavan, J. M. Redwing, **In situ stress measurements during the MOCVD growth of AlN buffer layers on (1 1 1) Si substrates**, Journal of Crystal Growth 261 (2004) 294–300
- [105] A. I. Shkrebtii, N. Esser, W. Richter, W. G. Schmidt, F. Bechstedt, B. O. Fimland, A. Kley, R. Del Sole, **Reflectance Anisotropy of GaAs(100): Theory and Experiment**, Physical Review Letters, Volume 81, No. 3, (1998)
- [106] H. Hardtdegen, N. Kaluza, R. Steins, Y.S. Cho, R. Schmidt, Z. Sofer, T. Trepk, J.-T. Zettler, **Observation of growth during the MOVPE of III-nitrides**, Journal de Physique IV. France 132 (2006) 177-183



- [107] M. Zorn, H. Wenzel, A. Knigge, U. Zeimer, M. Weyers,
Comparison of AlGaAs and AlInP cladding layers for red edge-emitting lasers, 10th European Workshop on MOVPE, Lecce (Italy) 8-11 June 2003
- [108] M. Belousov, B.Volf, J.C.Ramer, E.A. Armour, A. Gurary,
In situ metrology advances in MOCVD growth of GaN-based materials, Journal of Crystal Growth 272 (2004) 94-99
- [109] M. Zorn, T. Trepk, P. Kurpas, M. Weyers, J.-T. Zettler, W. Richter,
In situ monitoring and control of InGaP growth on GaAs in MOVPE, Journal of Crystal Growth 195 (1998) 223–227
- [110] K. Haberland, P. Kurpas, M. Pristovsek, J.-T. Zettler, M. Weyers, W. Richter,
Spectroscopic process sensors in MOVPE device production, Applied Physics. A 68, 309–313 (1999)
- [111] K. Haberland, A. Bhattacharya, M. Zorn, M. Weyers, J.-T. Zettler, W. Richter,
MOVPE Growth of (Al,Ga)InP-Based Laser Structures Monitored by Real-Time Reflectance Anisotropy Spectroscopy, 468 Journal of Electronics Materials, Vol. 29, No. 4, (2000)
- [112] P. Kurpas, A. Rumberg, M. Weyers, K. Knorr, T. Bergunde, M. Sato, W. Richter,
Growth monitoring by reflectance anisotropy spectroscopy in MOVPE for device fabrication, Journal of Crystal Growth 170 (1997), 203-207
- [113] M. Pristovsek, B. Han, J.-T. Zettler, W. Richter,
In situ investigation of GaAs (0 0 1) intrinsic carbon p-doping in metal-organic vapour phase epitaxy, Journal of Crystal Growth 221 (2000) 149-155
- [114] H. Hardtdegen, M. Pristovsek, H. Menhal, J.-T. Zettler, W. Richter, D. Schmitz,
In situ characterization of GaAs growth in nitrogen atmosphere during MOVPE: a comparison to hydrogen atmosphere, Journal of Crystal Growth 195 (1998) 211–216
- [115] M. Pristovsek, H. Menhal, T. Schmidling, N. Esser, W. Richter,
Comparative study of the GaAs (113), (115), (001), (115), (113), and (110) surfaces by atomic force microscopy, low energy electron diffraction, and reflectance anisotropy spectroscopy, Microelectronics Journal 30 (1999) 449–453
- [116] M. Pristovsek,
Fundamental growth processes on different Gallium Arsenide Surfaces in metal-organic vapor phase epitaxy, PhD thesis, TU-Berlin (2001)
- [117] D. Martin, J. Napierala, H. J. Bühlmann, M. Illegems,
In-situ reflectivity observation of GaN layers grown directly on sapphire by HVPE using low-temperature nucleation layers, Phys. stat. sol. (c) 2, No. 7, 2053–2057 (2005)
- [118] M.Zorn,
Optical in-situ Studies and on-line growth control of binary and Ternary III-V Semiconductors with respects to the (001) surface, PhD thesis, TU-Berlin (1999)
- [119] J. Han, M.H. Crawford, R.J. Shul, S.J. Hearne, E.Chason, J.J.Figiel, M. Banas,
Monitoring and controlling of strain during MOCVD of AlGaIn for UV optoelectronics, MRS Internet J. Nitride Semicond. Res. 4S1, G7.7 (1999)



- [120] J.-S. Lee, S. Sugou, H.-W. Ren, Y. Masumoto, K. Kurihara
In-Situ monitoring of In_{0.5}Ga_{0.5}As quantum dot formation during metalorganic vapour phase epitaxy by fast- nulling ellipsometry, Applied Surface Science 141 (1999) 114-118
- [121] J.R. Creighton, K.C. Baucom
Reflectance-difference spectroscopy of adsorbate-covered GaAs (100) surfaces: a combined surface science and in-situ OMVPE study, Surface Science 409 (1998) 372-383
- [122] Z. Sobierski, D.I. Westwood, P.J. Parbrook, K.B.Ozanyan, M. Hopkinson, C.R. Whitehouse
As/P exchange on InP (001) studied by reflectance anisotropy spectroscopy, American Institute of Physics, Application Physics Letter 70 (11) (1997)
- [123] K. B. Ozanyan, P.J. Parbrook, M. Hopkinson, C.R. Whitehouse, Z. Sobierski, D. I. Westwood
In-Situ monitoring of the surface reconstructions on InO(001) prepared by molecular beam epitaxy, American Institute of Physics, American J.Appl. Phys.82 (1997)
- [124] M. Arens, P. Kurpas, P. Ressel, M. Weyers
Real-time growth monitoring of InGaAs/ InP-HBT structures with reflectance anisotropy spectroscopy, Thin Solid Films 313-314 (1998) 609-613
- [125] N. Esser, A.I. Shkrebtii, U. Resch-Esser, C. Springer and W. Richter
Atomic Structure of the Sb-Stabilized GaAs (100)- (2 x 4) Surface, Physical Review Letters, Vol. 77, No. 21, (1996)
- [126] K. Christiansen, M. Luenenbueger, B. Schineller, M. Heuken, H. Juergensen
Advances in MOCVD technology for research, development, and mass production of compound semiconductor devices, Opto-electronics Review 10 (4), 237-242 (2002)
- [127] S.M. Scholz, A.B. Müller, W. Richter, D.R. T. Zahn, D. I. Westwood, D.A. Woolf, R. H. Williams
Analysis of molecular-beam epitaxial growth of InAs on GaAs (100) by reflection anisotropy spectroscopy, J. Vas. Sci. Technol. B 10 (4) Jul/Aug 1992
- [128] M. J. Begarney, C. H. li, D.C. Law, S.B. Visbeck, Y. Sun, R.F. Hicks,
Reflectance difference spectroscopy of mixed phases of indium phosphide (001), Applied Physics Letters, Vol. 78, Number 1, 2001
- [129] E. Steimetz, W. Richter, F. Schienle, D. Fischer, M. Klein, J.- T. Zettler
The Effect of Different Group V Precursors on the Evolution of Quantum Dots Monitord by Optical In Situ Measurements, Jpn. J. Appl, Phys. Vol. 37 (1998) pp 1483-1486
- [130] J.-S. Lee, S. Sugou, Y. Masumoto
In situ observation of ellipsometry monolayer oscillations of metalorganic vapour-phase epitaxy-grown III-V compound materials, Journal of Crystal Growth 2009 (2000) 614-620
- [131] J.-S. Lee, S. Sugou, H.-W. Ren, Y. Masumoto
In Situ ellipsometric study of the formation process of metalorganic vapour-phase epitaxy-grown quantum dots, Journal of Vacuum Science & Technology B, Vol. 17, Numer 4, July August, (1999)
- [132] J.-S. Lee, S. Sugou, H.-W. Ren, Y. Masumoto
Real-Time Observation of Ellipsometry Oscillation during GaAs Layer by Layer Growth by Metalorganic Vapor-Phase Epitaxy, Jpn. J. Appl. Phys. Vol. 38 (1999) pp. L 614- L 616
- [133] A. Krost, A. Dagar, G. Strassburger, R. Clos
GaN-based epitaxy on Silicon: stress measurements, phys. Stat. Sol (2003)/ DOI



- [134] P. R. Chalker, T. B. Joyce, T. Farrell, C. Johnston, A. Crossley, J. Eccles
Raman and reflection anisotropy spectroscopic studies of GaN and AlN growth on GaAs (100).
Thin Solid Films 343-344 (1999) 575-578
- [135] P.J. Parbrook, K.B. Ozanyan, M. Hopkinson, C.R. Whitehouse, Z. Sobiesierski, D. I. Westwood
Optical monitoring of InP monolayer growth rates, Applied Physics Letters, Vol. 73, Numer 3, 998
- [136] T.B. Joyce, T. Farrell, B. R. Davidson
Reflectance anisotropy spectroscopy studies of the growth of carbon-doped GaAs by chemical beam epitaxy, Journal of Crystal Growth 188 (1998) 211-219
- [137] Z. Sobiesierski, D. I. Westwood
Reflectance anisotropy spectroscopy and the growth of low-dimensional materials, Thin Solid Films 318 (1998) 140-147
- [138] C. Liu, S. Stepanov, P. A. Shields, A. Gott, W. N. Wang, E. Steimetz, and T. Zettler
Growth monitoring of ELO-GaN by EpiR DA TT optical sensor, submitted to APL.
- [139] I.M. Watson, C. Liu, E. Gu, M.D. Dawson, P.R. Edwards and R.W. Martin
Use of AlInN layers in optical monitoring of growth of GaN-based structures on free-standing GaN substrates, Applied Physics Letters, 2005, 87, 151901.
- [140] C.J. Deatcher, C. Liu, S. Pereira, M. Lada, A.G. Cullis, Y. J. Sun, O. Brandt, I.M. Watson
In situ optical reflectometry applied to growth of indium gallium nitride epilayers and multi-quantum well structures. Semicond. Sci. Technol. 18 (2003) 212-218
- [141] J.-T. Zettler, N. Esser,
Surface Kinetics and Applications in Process Control, Reflectance Anisotropy Spectroscopy Studies, Encyclopedia of Materials: Science and Technology, ISBN: 0-08-0431526, 9041-9045
- [142] H. Hardtdegen, N. Kaluza, Z. Sofer, Y.S. Cho, R. Steins, H.L. Bay, Y. Dikme, H. Kalisch, R.H. Jansen, M. Heuken, A. Strittmatter, L. Reißmann, D. Bimberg and J.-T. Zettler
New method for the in situ determination of Al_xGa_{1-x}N composition in MOVPE by real-time optical reflectance, Phys. stat. sol. (a) 203, No. 7, 1645–1649 (2006)
- [143] H. Hardtdegen, N. Kaluza, R. Steins, Y. S. Cho, Z. Sofer, M. Zorn, K. Haberland, J.-T. Zettler
Use of wafer temperature determination for the study of unintentional parameter influences for the MOVPE of III-nitrides, Phys. stat. sol. (b) 242, No. 13, 2581–2586 (2005)
- [144] B. Kim, S. Cho, Y. Shin, D. Kang, Y. Kim, Y. Park
Efficient method and layer design for calibrating compositions and growth rates of AlGaInP layers in 660-nm laser diodes grown by MOCVD, Journal of Crystal Growth 285 (2005), 327-332
- [145] M. Grabherr, D. Wiedenmann, R. Jäger, R. King
Fabrication and performance of tuneable single-mode VCSELs emitting in the 750 to 1000 nm range, Proceedings of SPIE 5737, 120 (2005)
- [146] A. Krost, F. Schulze, A. Dadgar, G. Strassburger, K. Haberland, T. Zettler
Simultaneous measurement of wafer curvature and true temperature during metalorganic growth of group-III nitrides on silicon and sapphire, Phys. Stat.sol. (b) 242, No. 13, 2570-2574 (2005)
- [147] M. Zorn, J.-T. Zettler, A. Knauer, M. Weyers
In situ determination and control of AlGaInP composition during MOVPE growth, Journal of Crystal Growth 287 (2006) 637-641



- [148] M. Grabherr, D. Wiedenmann, R. Jäger, R. King
Fabrication and performance of tuneable single-mode VCSELs emitting in the 750 nm range, U-L-M photonics GmbH, Ulm, Germany
- [149] C. Liu, S. Stepanov, A. Gott, P.A. Shields, E. Zharinov, W.N. Wang, E. Steimetz, J.T. Zettler
High temperature refractive indices of GaN, Phys. Stat. Sol. (c) 0002, 2003, DOI 10. 1002
- [150] C. Liu, S. Stepanov, P.A. Shields, A. Gott, W.N. Wang, E. Steimetz, J.-T. Zettler
In situ monitoring of GaN epitaxial lateral overgrowth by spectroscopic reflectometry, Applied Physics Letters 88, 101103 (2006)
- [151] R.M. Sieg, R.N. Sacks, S.A. Ringel
Application of pyrometric interferometry to the in-situ monitoring of InAlAs, InGaAs and quaternary alloy growth in InP substrates, Journal of Crystal Growth 175/176, 256 (1997)
- [152] I. M. Watson, C. Liu, K.-S. Kim, C.J. Deatcher, J.M. Girkin, M.D. Dawson, P.R. Edwards, C. Trager-Cowan, R. W. Martin
In situ and wx situ Evaluation of Mechanisms of Lateral Epitaxial Overgrowth, Phys. Stat.Sol. 188, No. 2, 743-746 (2001)
- [153] H. Hardtdegen, N. Kaluza, Z. Sofer, Y.S.Cho, R. Steins, H.L. Bay, Y. Dikme, H. Kalisch, R.H. Jansen, M. Heuken, A. Strittmatter, L. Reißmann, D. Bimberg, J.-T. Zettler
New method for the in situ determination of Al_xGa_{1-x}N composition in MOVPE by real-time optical reflectance, phys. stat. sol. (a) 203, No. 7, 1645–1649 (2006)
- [154] O. Reentilä, M. Mattila, M. Sopenan, H. Lipsanen
Nitrogen content of GaAsN quantum wells by in situ monitoring during MOVPE growth, Journal of Crystal Growth 290 (2006) 345-349
- [155] F. Brunner, S. Weeke, M. Zorn, M. Weyers
Growth monitoring of GaAsSb:C/InP heterostructures with reflectance anisotropy spectroscopy, Journal of Crystal Growth 272 (2004) 111-117
- [156] M. Zorn, T. Trepk, T. Schenk, J.-T. Zettler, M. Weyers
AlGaInP growth parameter optimisation during MOVPE for optoelectronic devices, Journal of Crystal Growth 298 (2007) 23-27
- [157] O. Reentilä, M. Mattila, L. Knuutila, T. Hakkarainen, M. Sopenan, and H. Lipsanen :
In situ determination of nitrogen content in InGaAsN quantum wells, Journal of Applied Physics 99, 1 (2006)
- [158] M. Zorn, F. Bugge, T.Schenk, U. Zeimer, M. Weyers, J.-T. Zettler
Feedback controlled growth of strain-balanced InGaAs multiple quantum wells in metal-organic vapour phase epitaxy using an in situ curvature sensor Semiconductor Science and Technology 21 (2006) L45-L48
- [159] Y. Cordier, N. Baron, F. Semond, J. Massies, M. Binetti, B. Henninger, M. Besendahl, T. Zettler
In situ measurements of wafer bending curvature during growth of group- III-nitride layers on silicon by molecular beam epitaxy Journal of Crystal Growth, 301-302 (2007), 71-74
- [160] F. Brunner, V. Hoffmann, A. Knauer, E. Steimetz, T. Schenk, J.-T. Zettler, M. Weyers
Growth optimization during III-Nitride multiwafer MOVPE using real-time curvature, reflectance and true temperature measurements Submitted to J.of Christal Growth
- [161] P. Weightman, D. S. Martin, R. J. Cole and T. Farrell
Reflection anisotropy spectroscopy, INSTITUTE OF PHYSICS PUBLISHING, Rep. Prog. Phys. **68** (2005) 1251–1341



- [162] M. Zorn, M. Weyers
Comprehensive study of (Al)GaAs Si-doping using reflectance anisotropy spectroscopy in metal-organic vapour-phase epitaxy, Journal of Physics D: Applied Physics, 40 (2007) 878–882
- [163] L.B. Freund, J.A. Floro, E. Chason
Extensions of the Stoney formula for substrate curvature to configurations with thin substrates or large deformations, Applied Physics letters, Vol. 74, Issue 14, 1987 (1999)
- [164] A. Dadgar, C. Hums, A. Diez, F. Schulze, J. Bläsing, A. Krost
Epitaxy of GaN LEDs on large substrates: Si or sapphire? Proc. SPIE 6355, 63550R (2006)
- [165] F. Schulze, A. Dadgar, J. Bläsing, A. Diez, A. Krost
Metalorganic vapor phase epitaxy grown InGaN/ GaN light-emitting diodes on Si (001) substrate, Applied physics letters 88, 121114 (2006)
- [166] A. Dadgar, C. Hums, A. Diez, J. Bläsing, A. Krost
Growth of blue GaN LED structures on 150-mm Si (1 1 1), Journal of Crystal Growth 297 (2006) 279-282
- [167] M. Hammar, J. Berggren, P. Sundgren, K. Haberland, E. Steimetz, J.-T. Zettler
In situ studies of metal-organic vapour-phase epitaxial growth of GaInNAs/GaAs QW structures using reflectance anisotropy spectroscopy, published in the EWMOVPE 2005 proceeding
- [168] Ch. Liu, Ian Watson
Quantitative simulation of in situ reflectance data from metal organic vapour phase epitaxy of GaN on sapphire. Semiconductor Science and Technology 22 (2007), 629-635.
- [169] Z.A. Ibrahim, A.I. Shkrebtii, M.J.G. Lee, K. Vynck, T. Teatro, W. Richter, T. Trepk, T. Zettler
Temperature dependence of the optical response: Application to bulk GaAs using first-principles molecular dynamics simulations. Physical Review B 77, 125218 (2008)
- [170] R. Clos, A. Dadgar, A. Knost
Wafer curvature in the nonlinear deformation range. Physica status solidi 201, No 11, R 75-R78 (2004)
- [171] A. Krost; A. Dadgar, F. Schulze, J. Bläsing, G. Strassburger, R. Clos, A. Diez, P. Veit, T. Hempel, J. Christen
In situ monitoring of the stress evolution growing group-III-nitride layers. Journal of Crystal Growth 275 (2005) 209-216.
- [172] O. Hunderi, J.-T. Zettler, K. Haberland
On the AlAs/GaAs (001) interface dielectric anisotropy. Thin Solid Films 472 (2005) 261-269
- [173] M. Zorn, J.-T. Zettler
Development and control of MOVPE growth processes for devices using reflectance anisotropy spectroscopy and normalized reflectance. Physica status solidi 242, No 13 (2005) 2587-2594.
- [174] K. Haberland, J. Mullins, T. Schenk, T. Trepk, L. Considine, A. Pakes, A. Taylor, J.-T. Zettler,
First real-time true wafer temperature and growth rate measurements in a closed-coupled showerhead MOVPE reactor during growth of InGa(AsP), Indium Phosphide and Related Materials, 2003, International Conference on, Volume , Issue , 12-16 May 2003 Page(s): 44 -47.
- [175] M. Pristovsek, T. Trepk, M. Klein, J.-T. Zettler, W. Richter,
Dynamic study of the surfaces of (001)GaAs in MOVPE during arsenic desorption, J. Appl. Phys., 87, (2000), 1245-1250.
- [176] F. Brunner, A. Knauer, T. Schenk, M. Weyers, J.-T. Zettler
Quantitative analysis of in situ wafer bowing measurements for III-nitride growth on sapphire. Journal of Crystal Growth 310 (2008) 2432 – 2438



- [177] A. Knauer, T. Kolbe, S. Einfeldt, M. Weyers, M. Kneissl, J-T. Zettler
Optimization of InGaN/(In,Al,Ga)N based near UV-LEDs by MQW strain balancing with in-situ wafer bow sensor. Phys. Stat. Sol. A **206**, No. 2, (2009) 211–214
- [178] A. Dadgar, R. Clos, G. Strassburger, F. Schulze, P. Veit, T. Hempel, J. Blasing, A. Krtschil, I. Daumiller, M. Kunze, A. Kaluza, A. Modlich, M. Kamp, A. Diez, J. Christen, A. Krost
Strains and stresses in GaN heteroepitaxy -sources and control. Advances in Solid State Physics 44 (2004) 313
- [179] A. Dadgar, M. Poschenrieder, I. Daumiller, M. Kunze, A. Strittmatter, T. Riemann, F. Bertram, J. Blasing, F. Schulze, A. Reiher, A. Krtschil, O. Contreras, A. Kaluza, A. Modlich, M. Kamp, L. Reißmann, A. Diez, J. Christen, F.A. Ponce, D. Bimberg, E. Kohn, A. Krost
Gallium-nitride-based devices on silicon. Phys. stat. sol. (c) **0**, No. 6, (2003) 1940- 1949
- [180] A. Dadgar, A. Strittmatter, J. Blasing, M. Poschenrieder, O. Contreras, P. Veit, T. Riemann, F. Bertram, A. Reiher, A. Krtschil, A. Diez, T. Hempel, T. Finger, A. Kasic, M. Schubert, D. Bimberg, F. A. Ponce, J. Christen, A. Krost
Metalorganic chemical vapor phase epitaxy of gallium-nitride on silicon. phys. stat. sol. (c) **0**, No. 6, 1583– 1606 (2003) 1583-1606
- [181] A. Dadgar, A. Krost.
MOVPE growth of GaN on Si. In: Paskova, Tanya (Hrsg.) ; Monemar, Bo (Hrsg.): Vacuum science and technology : nitrides as seen by the technology. Linköping : Research Signpost, 2002, S. 197 – 241
- [182] U. Seidel, B.E. Sagol, C. Pettenkofer, T. Hannappel
Electronic surface states on MOVPE-prepared InGa-terminated InGaAs(100) (4x2)/c(8x2) surface. Appl. Surf. Sci. (2008) 10.1016/j.apsusc.2008.07.017
- [183] U. Seidel, T. Hannappel
MOVPE preparation of InGaAs(100) surface reconstructions employing transient in-situ RDS. J. Cryst. Growth 310 (2008) 2334
- [184] U. Seidel, B.E. Sagol, B. Szabo, K. Schwarzburg, T. Hannappel
InGaAs/GaAsSb-interface studies in a tunnel junction of a low band gap tandem solar cell. Thin Solid Films 516 (2008) 6723
- [185] T. Bork, W.E. McMahon, J.M. Olson, T. Hannappel
Surface science studies including low temperature RDS on MOCVD-prepared, As-terminated Si(100) surfaces. J. Cryst. Growth 298 (2007) 54
- [186] U. Seidel, H.-J. Schimper, Z. Kollonitsch, K. Möller, K. Schwarzburg, T. Hannappel
Growth of an InGaAs/GaAsSb tunnel junction for an InP-based low band gap tandem solar cell. J. Cryst. Growth 298 (2007) 777
- [187] Z. Kollonitsch, H.-J. Schimper, U. Seidel, K. Möller, S. Neumann, F.-J. Tegude, F. Willig, T. Hannappel.
Improved structure and performance of the GaAsSb/InP interface in a resonant tunneling diode. J. Cryst. Growth 287 (2006) 536
- [188] Z. Kollonitsch, H.-J. Schimper, U. Seidel, F. Willig, T. Hannappel
In-situ monitoring and benchmarking in UHV of differently reconstructed InP/GaAsSb interfaces. Appl. Surf. Sci. 252 (2006) 4033



- [189] K. Möller, L. Töben, Z. Kollonitsch, Ch. Giesen, M. Heuken, F. Willig, T. Hannappel
In-situ monitoring and analysis of GaSb(100) substrate deoxidation. Applied Surf. Sci. 242 (2005) 392
- [190] T. Letzig, H.-J. Schimper, T. Hannappel, F. Willig
P-H bonds in the FTIR spectrum of the genuine MOCVD-grown ordered P-rich InP(100) surface. Phys. Rev. B 71 (2005) 033308
- [191] T. Hannappel, W.E. McMahon, J.M. Olson
An RDS, LEED, and STM study of MOCVD-prepared Si(100) surfaces. J. Cryst. Growth 272 (2004) 24
- [192] Z. Kollonitsch, K. Möller, F. Willig, T. Hannappel
Reconstructions of MOVPE-prepared group-V-rich GaAsSb(100) surfaces. J. Cryst. Growth 272 (2004) 694
- [193] Z. Kollonitsch, K. Möller, H.-J. Schimper, Ch. Giesen, M. Heuken, F. Willig, T. Hannappel
In situ monitored MOVPE growth of undoped and p-doped GaSb(100). J. Cryst. Growth 261 (2004) 289
- [194] F. Brunner, O. Reentilä, J. Würfl, M. Weyers
Strain Engineering of AlGaIn/GaN HFETs grown on 3 inch 4H-SiC. Phys. stat. sol.(c), vol. 6, no. S2, pp. S1065-S1068 (2009).
- [195] H. Döscher, Th. Hannappel, B. Kunert, A. Beyer, K. Volz, W. Stolz
In situ verification of single-domain III-V on Si(100) growth via metal-organic vapor phase epitaxy. Applied Physics Letters 93, 1 (2008)
- [196] C. Kruse, M. Gartner, A. Gust, D. Hommel
In situ observation of Zn-induced etching during CdSe quantum dot formation using time-resolved ellipsometry. Applied Physics Letters 90, 221102 (2007)
- [197] C. J. Tun, C. H. Kuo, Y. K. Fu, C. W. Kuo, C. J. Pan, G. C. Chi
Dislocation reduction in GaN with multiple Mg_xNy /GaN buffer layers by metal organic chemical vapor deposition. Applied Physics Letters 90, 212109 (2007)
- [198] D. G. Zhao, J. J. Zhu, Z. S. Liu, S. M. Zhang, Hui Yang, D. S. Jiang
Surface morphology of AlN buffer layer and its effect on GaN growth by metalorganic chemical vapor deposition. Applied Physics Letters V. 85, No. 9 (2004) 1499-1501
- [199] D. G. Zhao, D. S. Jiang, J. J. Zhu, Z. S. Liu, S. M. Zhang, Hui Yang, U. Jahn, K. H. Ploog
Al composition variations on AlGaIn films grown on low-temperature GaN buffer layer by metalorganic chemical vapor deposition. J. Cryst. Growth 310 (2008) 5266-5269
- [200] D. Zhu, C. McAleese, K.K. McLaughlin, M. Häberlen, C.O. Salcianu, E.J. Thrush, M.J. Kappers, W.A. Phillips, P. Lane, D.J. Wallis, T. Martin, M. Astles, S. Thomas, A. Pakes, M. Heuken, C.J. Humphreys
GaN-based LEDs grown on 6-inch diameter Si (111) substrates by MOVPE. To be published in Proc. SPIE, Vol. 7231, 723118 (2009)
- [201] D. Coquillat, M. Le Vassor d'Yerville, M. Kazan, C. Liu, I. M. Watson, P. R. Edwards, R. W. Martin, H. M. H. Chong, and R. M. De La Rue
Studies of the photonic and optical-frequency phonon properties of arrays of selectively grown GaN micropyramids. Journal of Applied Physics (2008), 044910.



- [202] E. M. Rehder, K. Tsai, P. Rice, C. R. Lutz, and K. S. Stevens
In Situ Monitoring of HBT Epi Wafer Production: The Continuing Push Towards Perfect Quality and Yields, CS MANTECH Conference, May 18th-21st, 2009, Tampa, Florida, USA
- [203] Andre Maaßdorf, M. Weyers
In-situ etching of GaAs/Al_xGa_{1-x}As by CBr₄, J. Cryst. Growth 310 (2008) 4754-4756
- [204] J.F. Geisz, A.X. Levander, A.G. Norman, K.M. Jones, M.J. Romero
In situ stress measurement for MOVPE growth of high efficiency lattice-mismatched solar cells, Journal of Crystal Growth 310 (2008) 2339–2344
- [205] Hongbo Yu, Deniz Caliskan, Ekmel Ozbay
Growth of high crystalline quality semi-insulating GaN layers for high electron mobility transistor applications, Journal of Applied Physics 100, 033501 (2006)
- [206] F. Bugge, M. Zorn, U. Zeimer, A. Pietrzak, G. Erbert, M. Weyers
MOVPE growth of InGaAs/GaAsP-MQWs for high-power laser diodes studied by reflectance anisotropy spectroscopy, Journal of Crystal Growth 311 (2009) 1065–1069
- [207] J. Décobert, N. Lagay, B. Thevenard
Optically in-situ monitored growth of carbon doped InAlAs by LP-MOVPE using CBr₄, Journal of Crystal Growth 310 (2008) 4813–4817
- [208] N. Baron, Y. Cordier, S. Chenot, P. Vennéguès, O. Tottereau, M. Leroux, F. Semond, and J. Massies
The critical role of growth temperature on the structural and electrical properties of AlGaIn/GaN high electron mobility transistor heterostructures grown on Si(111), Journal of Applied Physics 105, 033701 (2009)
- [209] V. Hoffmann, A. Knauer, F. Brunner, S. Einfeldt, M. Weyers, G. Tränkle, K. Haberland, J. -T. Zettler, M. Kneissl
Uniformity of the wafer surface temperature during MOVPE growth of GaN-based laser diode structures on GaN and sapphire substrate, to be published in Journal of Crystal Growth, ICMOVPE XV procedures 2010
- [210] S. Gutsch
Optical Monitoring of the MBE Growth of VCSEL structures: Report February 2007 – June 2007, University of Sheffield, Department of Electronics & Electrical Engineering, 4 June 2009
- [211] O. Reentilä, F. Brunner, A. Knauer, A. Mogilatenko, W. Neumann, H. Protzmann, M. Heuken, M. Kneissl, M. Weyers, G. Tränkle
Effect of the AlN nucleation layer growth on AlN material quality
J. Cryst. Growth, vol. 310, no. 23, pp. 4932-4934 (2008)