

Referências Bibliográficas

- [1] STEIL, T.; LUNING, J. *Fantastic Filling Stations*. St Paul, MN, USA: MBI, 2002. 1.1
- [2] WILSON, L. G. *Benjamin Silliman and His Circle: Studies in the Influence of Benjamin Silliman on Science in America*. New York, NY, USA: Science History Publications, 1979. 1.1
- [3] ENERGY INFORMATION ADMINISTRATION. *International Energy Outlook 2009*. Washington, DC, USA, 2009. 284 p. Disponível em: <[http://www.eia.doe.gov/oiaf/ieo/pdf/0484\(2009\).pdf](http://www.eia.doe.gov/oiaf/ieo/pdf/0484(2009).pdf)>. 1.1
- [4] SMITH, W. Effect of light on selenium during the passage of an electric current. *nature*, v. 7, p. 303–303, 1873. 1.3.1
- [5] PERLIN, J. Silicon Solar Cell Turns 50. NREL/BR-520-33947, National Renewable Energy Lab., Golden, CO.(US), 2004. 1.3.1
- [6] FONTAINE, B. et al. *Global market outlook for photovoltaics until 2013*. Brussels, Belgium, 2009. 20 p. Disponível em: <<http://www.epia.org/index.php?id=18>>. 1.3.1
- [7] HOVEL, H. *Semiconductors and semimetals*. New York, NY, USA: Academic Press, 1975. 2.1.1, 2.1.2, 3.3.1, 4.2.2
- [8] NELSON, J. *The physics of solar cells*. London, UK: Imperial College Press, 2003. 2.1.1, 2.1.1, 2.1.2, 3.3.1
- [9] GREEN, M. *Third generation photovoltaics: advanced solar energy conversion*. Berlin, Germany: Springer-Verlag, 2005. 2.1.1, 2.3
- [10] EISBERG, R.; RESNICK, R. *Quantum physics of Atoms, Molecules, Solids, Nuclei, and Particles*. New York, NY, USA: John Wiley & Sons Inc, 1985. 2.1.3
- [11] RIMADA, J. C. *Celdas solares de alta eficiencia en base a pozos cuánticos*. Tese (Doctor en Ciencias Físicas) — Instituto de Ciencia y Tecnología de los Materiales Laboratorio de Celdas Solares – Universidad de La Habana, Ciudad de la Habana, Cuba, 2006. 2.1.3, 4.3

- [12] ATKINS, P.; PAULA, J. D. *Atkins physical chemistry*. Oxford, UK: Oxford University Press, 2002. 2.3
- [13] SMITH, J.; NESS, H. V.; ABBOTT, M. *Introduction to chemical engineering thermodynamics*. New York, NY, USA: McGraw-Hill Science/Engineering/Math, 2005. 2.3
- [14] LANDSBERG, P.; TONGE, G. Thermodynamic energy conversion efficiencies. *Journal of Applied Physics*, v. 51, p. R1, 1980. 2.3
- [15] SHOCKLEY, W.; QUEISSER, H. Detailed Balance Limit of Efficiency of p-n Junction Solar Cells. *Journal of Applied Physics*, v. 32, p. 510, 1961. 2.3
- [16] HENRY, C. Limiting efficiencies of ideal single and multiple energy gap terrestrial solar cells. *Journal of applied physics*, v. 51, p. 4494, 1980. 2.3
- [17] TRUPKE, T.; GREEN, M.; WÜRFEL, P. Improving solar cell efficiencies by up-conversion of sub-band-gap light. *Journal of Applied Physics*, v. 92, p. 4117, 2002. 2.4.2
- [18] KOLODINSKI, S. et al. Quantum efficiencies exceeding unity due to impact ionization in silicon solar cells. *Applied Physics Letters*, v. 63, p. 2405, 1993. 2.4.3
- [19] SCHALLER, R.; KLIMOV, V. High efficiency carrier multiplication in PbSe nanocrystals: Implications for solar energy conversion. *Physical review letters*, APS, v. 92, n. 18, p. 186601, 2004. 2.4.3
- [20] CONIBEAR, G. et al. Silicon nanostructures for third generation photovoltaic solar cells. *Thin Solid Films*, Elsevier, v. 511, p. 654–662, 2006. 2.4.4
- [21] LI, J. et al. 35% efficient nonconcentrating novel silicon solar cell. *Applied Physics Letters*, v. 60, p. 2240, 1992. 2.4.5
- [22] LUQUE, A.; MARTÍ, A. Increasing the efficiency of ideal solar cells by photon induced transitions at intermediate levels. *Physical Review Letters*, APS, v. 78, n. 26, p. 5014–5017, 1997. 2.4.5
- [23] LUQUE, A.; MARTÍ, A.; CUADRA, L. High efficiency solar cell with metallic intermediate band. In: *Proc. 16th Eur. Photovoltaic Solar Energy Conf.* Glasgow, UK: Earthscan Publications, 2000. p. 59–61. 2.4.5
- [24] BARNHAM, K.; DUGGAN, G. A new approach to high-efficiency multi-band-gap solar cells. *Journal of Applied Physics*, v. 67, p. 3490, 1990. 2.4.5

- [25] JOHNSON, D. C. et al. Observation of photon recycling in strain-balanced quantum well solar cells. *Applied Physics Letters*, AIP, v. 90, p. 213505, 2007. 2.4.5, 6.2
- [26] ROHR, C. et al. InP-based lattice-matched InGaAsP and strain-compensated InGaAs/ InGaAs quantum well cells for thermophotovoltaic applications. *Journal of Applied Physics*, v. 100, p. 114510, 2006. 2.4.5, 6.2
- [27] DERKACS, D. et al. Nanoparticle-induced light scattering for improved performance of quantum-well solar cells. *Applied Physics Letters*, v. 93, p. 091107, 2008. 2.4.5
- [28] RIMADA, J. et al. Conversion efficiency enhancement of AlGaAs quantum well solar cells. *Microelectronics Journal*, Elsevier, v. 38, n. 4-5, p. 513–518, 2007. 2.4.5, 3.3, 4.2.3
- [29] RIMADA, J.; HERNANDEZ, L. Modelling of ideal AlGaAs quantum well solar cells. *Microelectronics Journal*, Elsevier, v. 32, n. 9, p. 719–723, 2001. 2.4.5, 3.2
- [30] ANDERSON, N. Ideal theory of quantum well solar cells. *Journal of Applied Physics*, v. 78, p. 1850, 1995. 3.1
- [31] NEAMEN, D. *Semiconductor physics and devices: basic principles*. New York, NY, USA: McGraw-Hill Science Engineering, 2002. 3.1, 3.1.1, 4.1.2
- [32] ZEGHBROECK, B. V. Principles of Semiconductor Devices. *Unpublished*, 2004. Disponível em: <<http://eceww.colorado.edu/bart/book/book/title.htm>>. 3.1, 3.1.1, 4.1.2, 4.1.4
- [33] COHEN-TANNOUDJI, C.; DIU, B.; LALOË, F. *Quantum mechanics. vol. 1-2*. New York, NY, USA: Wiley-Interscience, 2006. 3.2.2
- [34] BASTARD, G. *Wave Mechanics Applied to Semiconductor Heterostructures*. Les Ulis Cedex, France: Halsted Press, 1988. 3.2.2, 3.3.2
- [35] LADE, S.; ZAHEDI, A. A revised ideal model for AlGaAs/GaAs quantum well solar cells. *Microelectronics Journal*, Elsevier, v. 35, n. 5, p. 401–410, 2004. 3.3, 4.2.3
- [36] STOER, J. et al. *Introduction to numerical analysis*. New York, NY, USA: Springer-Verlag, 2002. 4.1.1
- [37] LEVEQUE, R. *Finite Difference Methods for Ordinary and Partial Differential Equations: Steady-State and Time-Dependent Problems (Classics in Applied*

- Mathematics Classics in Applied Mathematics). Philadelphia, PA, USA: Society for Industrial and Applied Mathematics, 2007.* 4.1.1
- [38] HARRISON, P.; HARRISON, P. *Quantum wells, wires, and dots: theoretical and computational physics*. New York, NY, USA: John Wiley & Sons, 2001.
4.1.1
- [39] KITTEL, C. *Introduction to Solid State Physics, 7th edn*. New York, NY, USA: John Wiley & Sons, 1996. 4.1.2
- [40] STREETMAN, B. *Solid state electronic devices*. Upper Saddle River, New Jersey, USA: Prentice Hall, 2000. 4.1.2
- [41] DALVEN, R. *Introduction to applied solid state physics*. New York, NY, USA: Plenum Press, 1990. 4.1.2
- [42] LI, E. Material parameters of InGaAsP and InAlGaAs systems for use in quantum well structures at low and room temperatures. *Physica E: Low-dimensional Systems and Nanostructures*, Elsevier, v. 5, n. 4, p. 215–273, 2000.
4.2.1, 4.2.1
- [43] HAMAKER, H. Computer modeling study of the effects of inhomogeneous doping and/or composition in GaAs solar-cell devices. *Journal of Applied Physics*, v. 58, p. 2344, 1985. 4.2.2
- [44] NELSON, J. et al. Steady-state carrier escape from single quantum wells. *IEEE Journal of Quantum Electronics*, v. 29, n. 6, p. 1460–1468, 1993. 4.2.3
- [45] ASPNES, D. et al. Optical properties of AlGaAs. *Journal of Applied Physics*, v. 60, p. 754, 1986. 4.2.4, 4.2.4
- [46] PAXMAN, M. et al. Modeling the spectral response of the quantum well solar cell. *Journal of Applied Physics*, v. 74, p. 614, 1993. 4.2.4, 4.2.4
- [47] PHILIPP, H.; EHRENREICH, H. Optical properties of semiconductors. *Physical Review*, APS, v. 129, n. 4, p. 1550–1560, 1963. 4.2.4
- [48] MICHALEWICZ, Z. *Genetic algorithms + data structures = evolution programs*. London, UK: Springer-Verlag, 1996. 5.1

A

Descrição das amostras

Abaixo são expostas a descrição das amostras utilizadas para validação dos modelos discutidos neste trabalho.

Camada	Repetição	Material	Espess.(nm)	Conc.(m^{-3})
Cap	1	<i>GaAs</i>	17	-
Camada P	1	$Al_{0,33}Ga_{0,67}As$	150	$1,3 \times 10^{(24)}$
Camada intrínseca	1	$Al_{0,33}Ga_{0,67}As$	510	-
Poços quânticos	50	<i>GaAs</i>	8.5	-
Camada N	1	$Al_{0,33}Ga_{0,67}As$	460	$1,3 \times 10^{(24)}$

Tabela A.1: Amostra G946

Camada	Repetição	Material	Espess.(nm)	Conc.(m^{-3})
Cap	1	<i>GaAs</i>	20	-
Camada P	1	$Al_{0,25}Ga_{0,75}As$	250	$7 \times 10^{(23)}$
Camada intrínseca	1	$Al_{0,35}Ga_{0,65}As$	483	-
Poços quânticos	30	<i>GaAs</i>	8.7	-
Camada N	1	$Al_{0,25}Ga_{0,75}As$	600	$2 \times 10^{(23)}$

Tabela A.2: Amostra QT76

Camada	Repetição	Material	Espess.(nm)	Conc.(m^{-3})
Cap	1	<i>GaAs</i>	40	-
Camada P	1	$Al_{0,36}Ga_{0,64}As$	150	$9 \times 10^{(23)}$
Camada intrínseca	1	$Al_{0,36}Ga_{0,64}As$	480	-
Poços quânticos	30	<i>GaAs</i>	8.4	-
Camada N	1	$Al_{0,36}Ga_{0,64}As$	600	$2,5 \times 10^{(23)}$

Tabela A.3: Amostra QT468A

Camada	Repetição	Material	Espess.(nm)	Conc.(m^{-3})
Cap	1	<i>GaAs</i>	40	-
Camada P	1	$Al_{0,36}Ga_{0,64}As$	150	$9 \times 10^{(23)}$
Camada intrínseca	1	$Al_{0,36}Ga_{0,64}As$	480	-
Poços quânticos	0	-	-	-
Camada N	1	$Al_{0,36}Ga_{0,64}As$	600	$2,5 \times 10^{(23)}$

Tabela A.4: Amostra QT468B

Camada	Repetição	Material	Espess.(nm)	Conc.(m^{-3})
Cap	1	<i>GaAs</i>	600	-
Cap	1	$Al_{0,8}Ga_{0,2}As$	45	$2 \times 10^{(24)}$
Camada P	1	$Al_{0,31}Ga_{0,69}As$	500	$2 \times 10^{(24)}$
Camada intrínseca	1	$Al_{0,31}Ga_{0,69}As$	800	-
Poços quânticos	50	<i>GaAs</i>	10	-
Camada N	1	$Al_{0,31}Ga_{0,69}As$	500	$6 \times 10^{(24)}$

Tabela A.5: Amostra QT229

Camada	Repetição	Material	Espess.(nm)	Conc.(m^{-3})
Cap	1	<i>GaAs</i>	20	-
Camada P	1	$Al_{0,35}Ga_{0,65}As$	150	$9 \times 10^{(23)}$
Camada intrínseca	1	$Al_{0,35}Ga_{0,65}As$	310	-
Poços quânticos	1	<i>GaAs</i>	5	-
Camada N	1	$Al_{0,35}Ga_{0,65}As$	600	$2,5 \times 10^{(23)}$

Tabela A.6: Amostra CB501