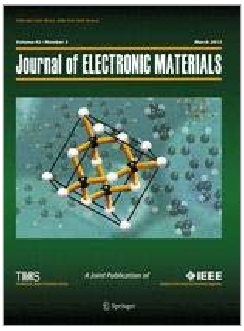
Journal of Electronic Materials
December 1995, Volume 24, Issue 12, pp 2005-2013

A composition-dependent model for the complex dielectric function of $In_{1-x}Ga_xAs_yP_{1-y}$ lattice-matched to InP

Abstract

Accurate and numerically efficient models for the complex dielectric function vs wavelength and material characteristics are essential for the use of nondestructive optical techniques such as spectroscopic ellipsometry or reflectometry. These optical techniques are commonly used for real-time and run-to-run monitoring and control of growth and etch processes to determine a material's composition and thickness. In this work, we discuss an improved composition-dependent model for the complex dielectric function for lattice-matched $In_{1-x}Ga_xAs_yP_{1-y}$/InP systems valid over the entire composition range $0 \le y \le 1$. We describe our model, which is an extension of the critical point parabolic band method and is based on the model proposed by Charles Kim et al. for the A_xGa_{1-x}/GaAs system. We demonstrate the quality of the model in fitting optical data for individual compositions and compare our results to other established models including the harmonic oscillator approximation and the model of Adachi. Using results obtained from the individual fits, we generate a composition-dependent model that is valid for the entire range of lattice-matched compositions. Also, we show how this model can be used to accurately determine the composition (±0.01) of an unknown material whose dielectric response has been obtained using spectroscopic ellipsometry or a similar technique.



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Journal

Journal of Electronic Materials
Volume 24, Issue 12 , pp 2005-2013

Cover Date

1995-12-01

DOI

10.1007/BF02653024

Print ISSN

0361-5235

Online ISSN

1543-186X

Publisher

Springer-Verlag

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