US005277747A

United States Patent [19]

Aspnes

[11] **Patent Number: 5,277,747**

[45] **Date of Patent: Jan. 11, 1994**

[54] **EXTRACTION OF SPATIALLY VARYING DIELECTRIC FUNCTION FROM ELLIPSOMETRIC DATA**

[75] Inventor: **David E. Aspnes**, Watchung

[73] Assignee: **Bell Communications Research, Inc.**, Livingston, N.J.

[21] Appl. No.: **945,086**

[22] Filed: **Sep. 15, 1992**

[51] **Int. Cl.**[5] **G01J 4/00**

[52] **U.S. Cl.** **156/626**; 437/8; 427/8; 118/712; 356/369; 204/192.13; 204/192.33; 204/298.03; 204/298.32

[58] **Field of Search** 156/626, 627; 437/8; 427/8-10; 118/712; 356/369; 204/192.13, 192.33, 298.03, 298.32

[56] **References Cited**

U.S. PATENT DOCUMENTS

4,332,833	6/1982	Aspnes et al.	156/626 X
4,676,644	6/1987	Canteloup	156/626 X
5,091,320	2/1992	Aspnes et al.	437/8
5,131,752	7/1992	Yu et al.	156/626 X

OTHER PUBLICATIONS

D. E. Aspnes et al., "Optical control of growth of $Al_xGa_{1-x}As$ by organometallic molecular beam epitaxy," Applied Physics Letters, 1990, vol. 57, pp. 2707-2709.

D. E. Aspnes et al., "Growth of $Al_xGa_{1-x}As$ parabolic quantum wells by real-time feedback control of composition," Applied Physics Letters, 1992, vol. 60, pp. 1244-1246.

D. E. Aspnes, "Optical Properties of Solids: New Developments," *Spectroscopic* Ellipsometry of Solids, 1976, B. O. Seraphin (ed.), North Holland, Amsterdam, p. 829.

Primary Examiner—Thi Dang

Attorney, Agent, or Firm—Leonard C. Suchyta

[57] **ABSTRACT**

A method of and apparatus for extracting dielectric constants from ellipsometric data taken during the growth of a semiconductor thin film and using the extracted dielectric constants to control the composition of the growing film by adjusting the growth conditions. An expression is used for the derivative of the pseudo-dielectric function with respect to the thickness of the thin film within a three-phase model, and the expression is exact to first order in thickness of the film. The expression is quadratic with respect to the dielectric function for a homogeneous thin film and additionally depends on the dielectric function of homogeneous substrate underlying the thin film. Values of the measured pseudo-dielectric function are substituted for the dielectric function of the substrate, and the expression is then solved for the dielectric function of the thin film.

11 Claims, 1 Drawing Sheet