

# **Reflection High-Energy Electron Diffraction and Reflection Electron Imaging of Surfaces**

Edited by

**P. K. Larsen**

Philips Research Laboratories  
Eindhoven, The Netherlands

and

**P. J. Dobson**

Philips Research Laboratories  
Redhill, United Kingdom

**Plenum Press**

New York and London

Published in cooperation with NATO Scientific Affairs Division

## CONTENTS

### SURFACE STRUCTURAL DETERMINATION

#### EXPERIMENTAL

- Experimental Overview of Surface Structure Determination  
by RHEED  
S. Ino 3

#### THEORY

- Surface Structural Determination Using RHEED  
J.L. Beeby 29
- Theory of RHEED by Reconstructed Surfaces  
M.G. Knibb and P.A. Maksym 43
- Accurate Dynamical Theory for RHEED Rocking-curve Intensity  
Spectra  
S.Y. Tong, T.C. Zhao and H.C. Poon 63

#### INELASTIC EFFECTS

- Inelastic Scattering Effects in RHEED and Reflection Imaging  
A.L. Bleloch, A. Howie, R.H. Milne and M.G. Walls 77
- Excitation of Dielectric Spheres by Electron Beams  
P.M. Echenique 91

### RESONANCE AND CHANNELING EFFECTS

- Resonance Effects in RHEED  
G. Meyer-Ehmsen 99
- Inelastic Scattering and Secondary Electron Emission Under  
Resonance Conditions in RHEED from Pt(111)  
H. Marten 109
- Adatom Site Determination Using Channeling Effects in RHEED  
on X-ray and Auger Electron Production  
J.C.H. Spence and Y. Kim 117

DISORDERS AND STEPS IN ELECTRON DIFFRACTION

Diffraction from Disordered Surfaces: An Overview M.G. Lagally, D.E. Savage and M.C. Tringides	139
Theory of Electron Scattering from Defect: Steps on Surfaces with Non-equivalent Terraces W. Moritz	175
Diffraction from Stepped Surfaces M. Henzler	193
RHEED and Disordered Surfaces B. Bölgér, P.K. Larsen and G. Meyer Ehmsen	201
Temperature Diffuse Scattering in RHEED M. Albrecht and G. Meyer-Ehmsen	211
Temperature Dependence of the Surface Disorder on Ge(001) Due to Ar <sup>+</sup> Ion Bombardment A.J. Hoeven, J.S.C. Kools, J. Aarts and P.C. Zalm	217
Two-dimensional First-order Phase Separation in an Epitaxial Layer T.-M. Lu and S.-N. Yang	225

CONVERGENT BEAM DIFFRACTION

Surface Convergent-Beam Diffraction for Characterization and Symmetry Determination J.A. Eades and M.D. Shannon	237
Convergent Beam RHEED Calculations Using the Surface Parallel Multislice Approach A.E. Smith	251

REFLECTION ELECTRON MICROSCOPY

USING CONVENTIONAL INSTRUMENTS

Reflection Electron Microscopy in TEM and STEM Instruments J.M. Cowley	261
Reflection Electron Microscopy with Use of CTEM: Studies of Au Growth on Pt(111) K. Yagi, S. Ogawa and Y. Tanishiro	285
Application of Reflection Electron Microscopy for Surface Science (observation of cleaned crystal surfaces of Si, Pt, Au and Ag) Y. Uchida	303
Reflection Microscopy in a Scanning Transmission Electron Microscope R.H. Milne	317

Contrast of Surface Steps and Dislocations Under Resonance, Non-resonance, Bragg, and Non-Bragg Conditions  
Tung Hsu and L.-M. Peng

329

MICROPROBE RHEED

- Microprobe Reflection High-energy Electron Diffraction  
M. Ichikawa and T. Doi 343

- Scanning RHEED Studies of Silicide Formation in a UHV-SEM  
P.A. Bennett and A.P. Johnson 371

LOW ENERGY INSTRUMENTS

- Low Energy Electron Reflection Microscopy (LEEM) and Its Application to the Study of Si Surfaces  
E. Bauer and W. Telieps 381

- Low Energy Scanning Electron Microscope  
T. Ichinokawa 385

ELECTRON DIFFRACTION STUDIES OF GROWTH

SEMICONDUCTORS

- RHEED Intensity Oscillations During MBE Growth of III-V Compounds - An Overview  
B.A. Joyce, J.H. Neave, J. Zhang and P.J. Dobson 397

- RHEED Oscillations Control of GaAs and AlAs MBE Growth Using Phase-lock Modulated Beams  
F. Briones, L. Gonzalez and J.A. Vela 419

- The Contribution of Atomic Steps to Reflection High energy Electron Diffraction from Semiconductor Surfaces  
P.R. Pukite, P.I. Cohen and S. Batra 427

- RHEED Studies of Growing Ge and Si Surfaces  
J. Aarts and P.K. Larsen 449

- LEED Investigations of Si MBE onto Si(100)  
M. Horn, U. Gotter and M. Henzler 463

METALS

- Quantitative Studies of the Growth of Metals on GaAs(110) Using RHEED  
D.E. Savage and M.G. Lagally 475

- RHEED Intensity Oscillations in Metal Epitaxy  
G. Lilienkamp, C. Koziol and E. Bauer 489

THEORY

- Calculation of RHEED Intensity from Growing Surfaces  
T. Kawamura 501

- Studies of Growth Kinetics on Surfaces with Diffraction  
M.C. Tringides and M.G. Lagally 523

- Index 539