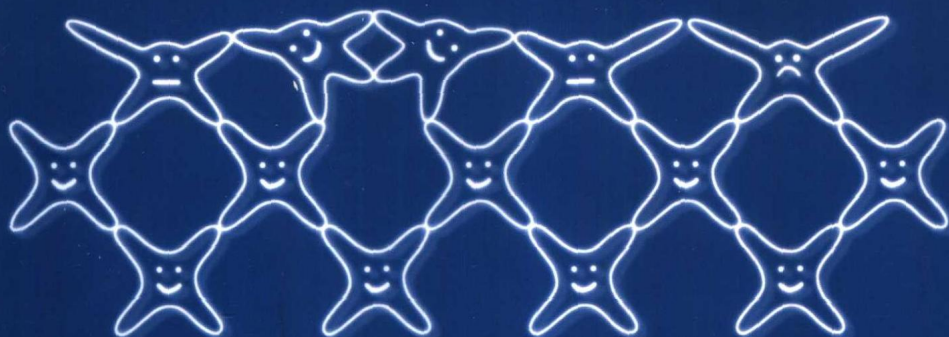
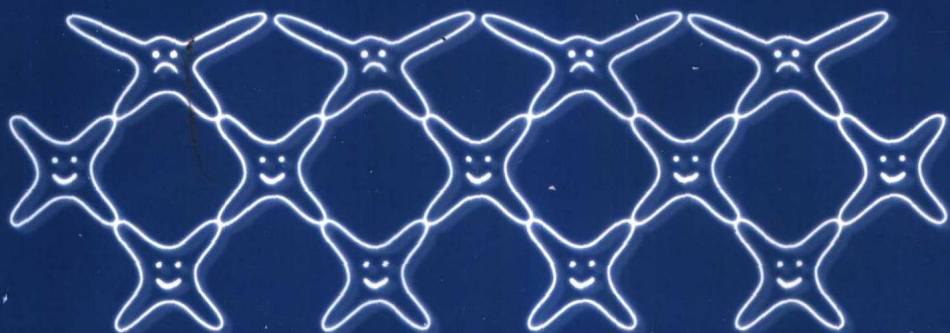


Silicon Surfaces and Formation of Interfaces

硅表面及界面的形成

J. Dabrowski, H-J. Müssig



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Silicon Surfaces and Formation of Interfaces

Basic Science in the Industrial World

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Silicon Surfaces and Formation of Interfaces

Basic Science in the Industrial World

To my Parents, and to Ewa and Wojtek,
for their understanding, patience, and love.

Moim Rodzicom oraz Ewie i Wojtkowi,
za ich zrozumienie, cierpliwość i miłość.

- J. D.

Preface

Silicon is the material of choice of the multibillion semiconductor industry. Ongoing miniaturization of microelectronic devices drives critical regions of integrated circuits ever closer to the place where the silicon ends and another material begins, to the interfacial region. Performance and reliability of electronic microelements depend more and more on the microscopic quality of the interfaces and on the microscopic-scale quality of the original Si surfaces. Suffice to say that as soon as in the first decade of the coming millenium the customers will be offered microelectronic chips with minimum features about hundred atoms long and a couple of atoms thick! Small wonder that atomic-scale knowledge is gaining a commercial value.

Determination of the atomic structure and the chemical bonding at semiconductor surfaces and interfaces is a demanding task. Advances in the experimental and computational techniques make this task increasingly manageable. The work of physicists is assisted by dramatic improvements in the performance of computers. Fruitful interaction between predictable theories and reliable experiments has greatly influenced our knowledge on the intricate relationship between the behavior of individual atoms and the behavior of mesoscopic and macroscopic objects. We are approaching the ultimate practical goal of modern semiconductor surface research: efficient usage of microscopic information in the control of semiconductor structure and chemistry and, consequently, efficient control of technological processes and design of optimal circuits and systems.

The main objective of this book is to give a comprehensive overview of silicon surfaces and interfaces: what is known and unknown about them from scientific point of view, what is their industrial role, what are the

relations between applications and basic research, what are the most probable directions of future developments. Since the scope is broad and the volume small, I took care to avoid the danger that this presentation evolves into an unreadable encyclopaedia accessible only to experts. In fact, there is no particular reason to compile all the data; first, this has been done many times before, and second, this would be a task for a large team. So I decided to focus not on numbers and curves, but on problems. A reader interested in more details is often asked to consult an easily available book or a journal article.

Each technical chapter begins with a general overview, intended to be understandable to any person with some basic knowledge on solid state physics. Individual Sections begin with overviews as well, but these have a more specialized character. Subsections deal with their subjects much more thoroughly and they do not avoid controversial or speculative issues. We have used the advantage of the storyteller and limited the scope of material covered in detail to the topics we found either most interesting or of a major practical importance.

Practical importance is likely to invoke scientific interest. But many subjects which are scientifically interesting have no technological relevance. When combined with lame budgets of many governments, an unfortunate but far-reaching consequence of this trivial fact may be that science will be commercialized. Let us hope that scientists will eventually contain this danger by recognizing the problem, by some self-control, and by occasional refreshing exercises in broader, even philosophically oriented thinking.

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Jarek Dąbrowski

Frankfurt (Oder), 9 May 1999

Contents

Preface

vii

1. Fundamental Concepts and Methods 1

Silicon as a technological material. Basic concepts. How to determine the atomic structure of a surface and why this determination is needed. Silicon surfaces on the (001) to (110) azimuth.

1.1. Introduction 1

1.2. The Silicon Age 3

1.2.1. The omnipresent silicon 4

1.2.2. The MOS technology 7

Miniaturization. Technological MOS processes.

1.3. Methods of Modern Surface Science 14

1.3.1. Theoretical techniques 15

Approximations in *ab initio* studies. Convergency issues. Tight-binding methods.

1.3.2. Experimental techniques 28

Scanning Tunneling Microscopy (STM) and Spectroscopy (STS). Atomic Force Microscope (AFM). Low Energy Electron Diffraction (LEED). Auger Electron Spectroscopy (AES). X-Ray Photoelectron Spectroscopy (XPS). Ultraviolet Photoelectron Spectroscopy (UPS). Absorption and Diffraction of X-Rays. Ion Spectroscopies. High Resolution Electron Energy Loss Spectroscopy (HREELS). Other Surface Science Techniques .

1.4. Silicon Surfaces and Interfaces 45

1.4.1. Fundamental concepts 46

Ideal truncated bulk and surface energy. Realistic clean surfaces.

1.4.2. Free surfaces 53

Defects on the surface and in the bulk. Adsorption and epitaxial growth. Desorption, etching, cleaning, cleaving.

1.4.3. Buried interfaces 65

1.5. Primary Silicon Surfaces and Their Vicinals 67

1.5.1. Structures of Si(001) 68

1.5.2. Structures of Si(111) 69

1.5.3. Si(11 n) surfaces 73

1.5.4. Structures of Si(113) 74

1.5.5. Structures of Si(110) 78

| | |
|---------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 2. The Famous Reconstruction of Si(001) | 82 |
| <i>How the reconstruction of the clean Si(001) was unraveled and what can one learn from this story.</i> | |
| 2.1. Introduction | 82 |
| 2.1.1. Overview: expectations bias our predictions | 84 |
| 2.2. Pre-STM Era: Groping through the Dark | 87 |
| 2.2.1. Early observations and models | 88 |
| The first idea: 2×1 order of dimers. The first alternative and the first puzzle. | |
| 2.2.2. Dimers, chains, vacancies, or maybe something else? . . . | 93 |
| Soft phonons, double bonds, and rediscoveries. New data: electronic structure. New models and new arguments against dimers. LEED and subsurface strain. | |
| 2.2.3. The mysterious fourfold periodicity strikes back | 99 |
| 2.2.4. Buckling of dimers | 100 |
| Chadi's buckled dimers. Buckling supported by experiments. Buckling supported by theory. | |
| 2.2.5. Simple models lose some credit | 102 |
| Quantum chemistry reports problems. Pandey's missing dimers. Northrup's chain-dimer model. | |
| 2.3. To Buckle or Not to Buckle? | 107 |
| 2.3.1. The first group photo of dimers | 107 |
| What did STM reveal. What STM could not reveal. | |
| 2.3.2. Electronic structure attracts more attention | 109 |
| Problems with the band gap. | |
| 2.3.3. Seeing is believing | 112 |
| SCLS revisited: dimers are symmetric. Surface stress: symmetric dimers are OK. Energy minimization: you get what you want. | |
| 2.3.4. The sobering variety of opinions | 115 |
| 2.4. A Clear Picture Finally Emerges | 117 |
| 2.4.1. Reconciliations | 117 |
| SCLS revisited: polemics. Theory, STM, and SCLS agree. | |
| 2.4.2. Completing the picture | 120 |
| 2.5. Conclusions and Summary | 122 |
| 2.5.1. What did we learn | 122 |
| 2.5.2. What is still missing | 124 |

3. Geometries of Clean Si(001) 127

Atomic and electronic structures of perfect and defected Si(001).

3.1. Introduction 127

3.2. Perfect Si(001) 130

3.2.1. The {001}-truncated bulk 131

3.2.2. Atomic structures 133

Dimerization. Buckling of dimers. Bond angles and dimer bond length. Surface stress.

3.2.3. Electronic structures 142

Electronic states of a dimer and the 2×1 bands. The $c(4 \times 2)$ surface bands. Interpretation of photoemission data. Photoemission data: open questions. Scanning tunneling microscopy. Core states and surface core level shifts.

3.3. Surface Defects 155

3.3.1. Point defects 155

A- and B-type defects: missing dimers. C-type defects: Subsurface vacancies?.

3.3.2. Surface steps and vicinal Si(001) 171

Monatomic steps. Biatomic steps.

3.4. Metastable Structures 194

3.4.1. Si(001) $2 \times n$ 194

3.4.2. Si(001) $c(4 \times 4)$ 198

3.4.3. Translational domain boundaries 201

4. Evolution of Clean Si(001) 205

Dynamic properties. Diffusion, phase transitions, morphology evolution.

4.1. Introduction 205

| | |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 4.2. Surface Diffusion | 206 |
| 4.2.1. Isolated mobile objects on clean Si(001) | 207 |
| Monomers and their diffusion. Ad-dimers and their diffusion. Diffusion of dimer vacancies. | |
| 4.2.2. Interactions between mobile objects on Si(001) | 216 |
| Interaction between monomers. Monomer-ad-dimer and ad-dimer-ad-dimer interactions. Interaction between dimer vacancies. Interaction of vacancies with ad-dimers and monomers. | |
| 4.2.3. Interactions between mobile objects and Si(001) steps . . | 222 |
| Monomers in vicinity of steps. Ad-dimers, vacancies, and evolution of step edges. Electromigration. | |
| 4.3. Surface Vibrations and Phase Transitions | 237 |
| 4.3.1. Surface transitions on the flat Si(001) | 238 |
| Structures, vibrations, and the Ising hamiltonian. Stability of phases. Influence of surface point defects. Influence of surface steps. | |
| 4.3.2. Vicinal Si(001): phase transitions, interaction of steps . . | 249 |
| 4.4. Deposition and Sublimation of Si | 256 |
| 5. Adsorption on Silicon Surfaces | 262 |
| <i>Interaction of foreign atoms and molecules with Si surfaces. Adsorption sites, the nature of bonding, surface diffusion.</i> | |
| 5.1. Introduction | 262 |
| 5.2. Hydrogen: Passivation and Etching | 264 |
| 5.2.1. Hydrogen adsorption, etching, and structures on Si(001) | 265 |
| 5.2.2. Desorption of hydrogen and buckling of dimers | 269 |
| 5.2.3. Hydrogen and epitaxial growth | 275 |
| 5.3. Halogens: Etching | 277 |
| 5.3.1. Fluorine and hydrofluoric acid | 278 |
| 5.3.2. Chlorine, bromine and iodine | 282 |
| 5.4. Oxygen: Isolation and Protection | 286 |
| 5.4.1. Oxygen and its bonds with silicon | 288 |
| 5.4.2. Adsorption of O ₂ on Si(001) | 289 |
| 5.4.3. Adsorption sites of atomic oxygen on Si(001) | 290 |
| Silanone complexes and silicon ejection. Oxygen atoms in Si-Si bonds. Surface defects and initial stages of oxidation. | |
| 5.4.4. Active etching and passive oxidation | 294 |

| | |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 5.5. Water: UHV Pest and a Renowned Oxidant | 296 |
| 5.5.1. Water, ice, and hydrogen bonds | 298 |
| 5.5.2. Adsorption and dissociation of water | 301 |
| 5.5.3. Oxidation and etching by water | 304 |
| 5.6. Nitrogen: a Hope for a Better Gate Dielectric | 308 |
| 5.6.1. Nitrogen, silicon nitride, and related materials | 311 |
| 5.6.2. Adsorption of nitrogen-containing molecules | 314 |
| 5.6.3. Nitridation of silicon | 318 |
| 5.7. Transition Metals: Contacts, Dielectrics, Impurities | 322 |
| 5.7.1. Transition metal silicides on silicon | 324 |
| Titanium, tungsten, and platinum silicides. CaF_2 structures: Ni and Co disilicides and interfaces. | |
| 5.7.2. Nickel on silicon surfaces | 335 |
| 5.7.3. Titanium on Si(001) | 339 |
| 5.7.4. Transition metal oxides: new gate dielectrics? | 341 |
| 6. On the Road to Devices: $\text{SiO}_2/\text{Si}(001)$ | 344 |
| <i>Physics of SiO_2/Si interfaces viewed from the perspective of basic science and semiconductor technology. Methods and mechanisms of oxide growth. Interface roughness, atomic and electronic structures, and interaction with foreign atoms. Influence of interfaces on MOSFET electrical parameters. Reliability issues.</i> | |
| 6.1. Introduction | 344 |
| 6.2. Silicon Dioxide in Nature and Technology | 346 |
| 6.2.1. Silicon dioxide, SiO_2 | 348 |
| 6.2.2. $\text{SiO}_2/\text{Si}(001)$: MOS technology views and limits | 352 |
| 6.3. Preparation of Oxide Films | 357 |
| 6.3.1. Native oxides and oxidation by chemical etch | 359 |
| 6.3.2. Thermal oxidation | 362 |
| 6.3.3. Growth by deposition | 366 |
| 6.3.4. Nitridation and oxynitridation | 367 |
| 6.3.5. Silicon dioxide film morphology | 372 |
| Pinholes. Stress field in SiO_2 . Microcrystallites and homogeneity. | |
| 6.3.6. Post-oxidation treatments | 375 |
| 6.3.7. Isolation techniques | 377 |

| | |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 6.4. Models of Thermal Oxidation | 380 |
| 6.4.1. Deal-Grove model of growth rate | 382 |
| 6.4.2. Beyond the Deal-Grove model | 384 |
| Diffusing and reacting species. Space-charges, stress, and defects. The practical approach. | |
| 6.5. Formation and Structures of SiO₂/Si Interfaces | 391 |
| 6.5.1. Interface formation: a simple analysis | 394 |
| 6.5.2. Atomic structures of SiO ₂ /Si(001) | 398 |
| Non-stoichiometric layer: SiO _x . Three classes of SiO ₂ /Si(001) models. Class 1: tridymite-based models. Class 2: cristobalite-based models. Class 3: random network interface. | |
| 6.5.3. Electronic states in the gap | 406 |
| 6.5.4. Oxide defects and growth of the oxide | 408 |
| Growth at low temperatures. Effect of high temperatures. Defects, regrowth, and stress. | |
| 6.5.5. Reactions at the interface and in the oxide film | 412 |
| Main reactions during oxidation. Chlorine and fluorine: dielectric strength, dopant diffusion. Dopants: Fermi level, penetration, segregation. Hydrogen, nitrogen, oxygen: control of stress and traps. | |
| 6.6. Practical Quality Issues of SiO₂/Si | 429 |
| 6.6.1. Experimental access | 429 |
| 6.6.2. Influence on device parameters | 430 |
| Oxide failure and leakage current. Drive current and high-frequency performance. Instabilities and noise. Threshold voltage. | |
| 7. Afterword | 445 |
| <i>Philosophical remarks. The industry knows enough to produce better and better devices; who needs basic research? Conclusions and outlook.</i> | |
| 7.1. Do We Need an Afterword? | 445 |
| 7.2. A Glance Behind | 446 |
| 7.3. Fundamental Science in a Commercial World | 447 |
| 7.3.1. The dangers of commercialization | 448 |
| 7.3.2. Can science be saved? | 449 |
| 7.3.3. Science for technology | 450 |
| 7.3.4. Science for all | 452 |

| | |
|--------------------------------------------------|------------|
| 7.4. How Can Silicon Surfaces Contribute? | 458 |
| 7.5. Overview and Summary | 460 |
| References | 463 |
| Author Index | 507 |
| Subject Index | 533 |

List of Figures

| | | |
|------|-------------------------------------------------------------------------------------------------------------------------------------|-----|
| 1.1 | Atomic and electronic structures of crystalline silicon . . . | 5 |
| 1.2 | MOS field effect transistor (MOSFET) | 8 |
| 1.3 | Basic MOS transistors used in memory cells | 9 |
| 1.4 | Miniaturization of MOSFETs: oxide thickness and feature size | 11 |
| 1.5 | Ball-and-stick models of several bulk-terminated surfaces . | 48 |
| 1.6 | Ball-and stick models of Si(111) 2×1 and 7×7 | 70 |
| 1.7 | STM images of Si(111) 7×7 | 72 |
| 1.8 | Ball-and-stick models of Si(113) reconstructions | 75 |
| 1.9 | STM images of Si(113) 3×2 | 78 |
| 1.10 | Ball-and stick models of Si(110) reconstructions | 80 |
| 1.11 | STM images of Si(110) reconstructions | 81 |
| 2.1 | Development of opinions about the structure of Si(001) . . | 85 |
| 2.2 | A schematic representation of the 1×1 surface cell of Si(001) and the different periodicities observed on the clean surface | 89 |
| 2.3 | Dimerization on Si(001). Truncated-bulk surface, Schlier and Farnsworth, Green and Seiwatz, and Chadi models . . | 90 |
| 2.4 | Si(001) models based on rehybridization of surface atoms . | 91 |
| 2.5 | Si(001) models based on simple surface dimers | 93 |
| 2.6 | Si(001) models based on ad-dimers and/or dimer chains . . | 94 |
| 2.7 | Pandey's "missing dimer" (" π -bonded defect") model . . . | 106 |
| 2.8 | One of the first STM images of Si(001) | 108 |
| 2.9 | Miniaturization drives technology into the atomic regime . | 123 |
| 3.1 | {001}-truncated Si bulk. Monatomic and biatomic steps . | 130 |
| 3.2 | Atomic orbitals of the ideal, {001}-truncated bulk Si . . . | 132 |
| 3.3 | Si(001) imaged by STM, AFM, and electron holography . . | 135 |
| 3.4 | The mechanism of Jahn-Teller distortion | 136 |
| 3.5 | Electronic structures of Si(001) dimers | 144 |
| 3.6 | Brillouin zones of Si(001) 2×1 and Si(001) $c(4\times 2)$ | 146 |
| 3.7 | Measured and computed surface bands of clean Si(001) . . | 148 |
| 3.8 | STM images of Si(001) dimers | 150 |
| 3.9 | Voltage-dependent STM images of Si(001) dimers | 151 |
| 3.10 | Si(001) SCLS peaks | 152 |
| 3.11 | STM image of missing dimer vacancies | 158 |
| 3.12 | Atomic configurations of a single dimer vacancy, top views | 159 |

| | | |
|------|-------------------------------------------------------------------------------------------------------------------------------|-----|
| 3.13 | Atomic configurations of various dimer vacancies | 164 |
| 3.14 | Ball-and-stick models of the C-defect | 167 |
| 3.15 | C-type defects: STM images and a proposed charge-dependent relaxation mechanism of Fermi level pinning . . | 168 |
| 3.16 | Stepped Si(001) surface morphologies on the (001) to (<i>nn</i> 1) azimuth: monatomic, mixed, and biatomic step phases . . . | 172 |
| 3.17 | The popular Chadi's classification of Si(001) steps | 173 |
| 3.18 | Ball-and-stick models of basic Si(001) step geometries . . . | 175 |
| 3.19 | A typical STM image of a vicinal Si(001) with monatomic steps: S_B steps are much rougher than S_A steps | 176 |
| 3.20 | S_B -s, S_B -dv, and S_B -r steps on Si(001) | 179 |
| 3.21 | Dimer buckling at monatomic Si(001) steps: S_A versus S_B . . | 180 |
| 3.22 | Buckling of dimers and rebonding atoms at S_B steps | 181 |
| 3.23 | Energetics of S_A and S_B steps | 184 |
| 3.24 | Two monatomic Si(001) steps meeting at a "kissing site" . . | 185 |
| 3.25 | Calculated electronic structure of S_B -s and S_B -r steps . . . | 186 |
| 3.26 | Step energy differences versus step-step separation | 190 |
| 3.27 | Correlation between dimerization phase on Si(001) terraces separated by rough D_B steps | 192 |
| 3.28 | Buckling of dimers on straight and kinked D_B steps | 193 |
| 3.29 | The Si(001) $2 \times n$ reconstruction (dimer vacancy rows) . . . | 196 |
| 3.30 | Metastable $c(4 \times 4)$ reconstructions of clean Si(001) | 200 |
| 4.1 | Kink dynamics on S_B steps of Si(001) | 230 |
| 4.2 | Interaction between ad-dimers and Si(001) steps | 234 |
| 4.3 | Spin representation of buckling phases on flat Si(001) . . . | 239 |
| 4.4 | Order-disorder transition on flat Si(001): snapshots of simulated surface | 244 |
| 4.5 | Order-disorder transition on flat Si(001): order parameter and LEED intensities | 246 |
| 4.6 | Order-disorder transition on flat Si(001): streak structure . | 247 |
| 4.7 | Schematic phase diagram of vicinal Si(001) | 250 |
| 4.8 | Wavy steps on flat Si(001) | 251 |
| 4.9 | Influence of strain on orientational domains of Si(001) . . . | 255 |
| 5.1 | H/Si(001): adsorption and desorption kinetics | 267 |
| 5.2 | Atomic structure of dihydrides and a trihydride on Si(001) . | 269 |
| 5.3 | Active and passive oxidation regimes of silicon surfaces . . | 294 |
| 5.4 | Temperature dependence of SiO desorption from Si(001) . . | 295 |