University of Technology, Sydney

Doctoral Thesis

Localised Probing of Precursor Coefficients Using Electron Beam Induced Deposition and Etching

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Declaration of Authorship

I, Jared Craig Cullen, declare that this thesis titled, Localised Probing of Precursor Coefficients Using Electron Beam Induced Deposition and Etching, and the work presented in it is my own.

- I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as fully acknowledged within the text.
- I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

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UNIVERSITY OF TECHNOLOGY, SYDNEY

Abstract

Faculty of Science

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Localised Probing of Precursor Coefficients Using Electron Beam Induced Deposition and Etching

by Jared Craig CULLEN

Electron beam induced etching (EBIE) and deposition (EBID) are direct-write deposition techniques in which an electron beam is used for chemical precursor dissociation. Both techniques are capable of nanometer-scale resolution, but applications have been limited by poor understanding of the underlying reaction mechanisms and rate parameters. Here, a hybrid Continuum-Monte Carlo model has been designed and implemented, enabling modelling of the temporal and spatial evolution of nanostructures fabricated by EBID and EBIE. This hybrid model is used to perform Arrhenius analysis of the deposition rates of nanostructures grown by EBID and EBIE, from which both precursor desorption and diffusion rate parameters can be obtained. These parameters are of fundamental interest in physical chemistry and surface science fields but also are key to optimisation of chemical vapour deposition (CVD), EBID, EBIE, and related surface processing and nanofabrication techniques. Methods used to determine the activation energy and pre-factors for desorption and diffusion are described in detail. The limitations of these methods, growth conditions needed to minimise errors, and applications to the chemistry, physics and nanotechnology communities are also discussed.

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Contents

Declaration of Authorship **ii**

Abstract **iii**

Acknowledgements **iv**

List of Figures **viii**

List of Tables **xiii**

1 Introduction **1**
- 1.1 Project Objectives and Approach . . . 1
- 1.2 Thesis Outline . . . 2
- 1.3 Published Work . . . 3

2 Literature Review **4**
- 2.1 Physical Processes . . . 5
  - 2.1.1 Adsorption . . . 5
  - 2.1.2 Desorption . . . 6
  - 2.1.3 Surface Diffusion . . . 7
  - 2.1.4 Electron Induced Dissociation . . . 7
- 2.2 Experimental Applications . . . 8
  - 2.2.1 The Effect of Various Experimental Parameters . . . 9
  - 2.2.2 Resolution of EBID structures . . . 11
- 2.3 Modelling Methods . . . 13
  - 2.3.1 Continuum Models . . . 13
  - 2.3.2 Monte Carlo Models . . . 17
- 2.4 Summary . . . 21

3 Hybrid Continuum-Monte Carlo Model **22**
- 3.1 Continuum Equations . . . 25
  - 3.1.1 Discretization of Time and Space . . . 27
  - 3.1.2 Verification . . . 30
- 3.2 Electron Trajectory Simulation . . . 33
  - 3.2.1 Single Scattering Model . . . 35
  - 3.2.2 Parametric Model . . . 39

3.2.3 Model Extensions . . . 40
3.2.3.1 Backscattered & Forward Scattered Electrons . . . 40
3.2.3.2 Secondary Electrons . . . 40
3.2.4 Verification . . . 43
3.3 Model Extensions . . . 45
3.3.1 Surface Evolution & Electron Beam Projection . . . 46
3.3.2 Surface Diffusion Modelling . . . 46
3.3.2.1 Free Form Movement . . . 50
3.3.2.2 Area Remapping . . . 51
3.3.3 Verification . . . 53

4 Hybrid Model Simulator Details 55
4.1 User Operation . . . 55
4.2 Tutorial: How to run the EBIED simulator . . . 58
4.2.1 Mac OS X . . . 58
4.2.2 Ubuntu - Linux . . . 60
4.3 Summary of Parameters within the EBIED Simulator Input File . . . 61
4.3.1 Simulation Parameters . . . 61
4.3.2 Electron Beam Parameters . . . 62
4.3.3 Material Parameters . . . 63
4.3.4 Precursor Parameters . . . 65
4.3.5 Module Toggles . . . 67
4.3.6 Miscellaneous Parameters . . . 68
4.4 Summary of Outputs from the EBIED Simulator . . . 69
4.5 Summary of Warning and Error Messages within the EBIED Simulator . . 70

5 Localized Probing of Gas Molecule Adsorption Energies and Desorption Attempt Frequencies 74
5.1 Introduction . . . 74
5.2 Arrhenius analysis of deposition rates . . . 76
5.2.1 Athermal adsorption flux condition . . . 81
5.2.2 Reaction-rate limited growth condition . . . 82
5.2.3 Negligible diffusion condition . . . 84
5.2.4 Steady state growth condition . . . 85
5.3 General implications for the determination of adsorbate properties . . . 86
5.4 Conclusion . . . 88

6 Electron Beam Induced Deposition As a Technique for the Analysis of Precursor Molecule Diffusion Barriers and Pre-Factors 89
6.1 Introduction . . . 89
6.2 Roles of Desorption and Diffusion in EBID . . . 90
6.3 Adsorbate Transport Through Diffusion . . . 91
6.4 Extraction of Diffusion Energies and Pre-Exponential Factors . . . 94
6.5 Pre-requisites . . . 98
6.5.1 Condition 1 - Steady State Growth . . . 99

6.5.2 Condition 2 - Significant adsorbate concentration gradient 99
6.5.3 Condition 3 - Diffusion-dominated replenishment 100
6.5.4 Condition 4 - Efficient adsorbate consumption 101
6.6 Limitations of the Arrhenius analysis method 103
6.7 Conclusion 104

7 Conclusion **106**

A Diffusion Test Code **107**

B Hybrid Continuum-Monte Carlo Simulator Code **112**
B.1 Constants 112
B.2 Variable Structures 112
B.3 Function Prototypes 114
B.4 Simulator Core 119
B.5 EBID/EBIE & EBIED Solver 142
B.6 Electron Flux Profile 153
B.7 Linear Interpolation 157
B.8 Monte Carlo Data Collection 158
B.9 Monte Carlo Electron Trajectories 162
B.10 Monte Carlo Surface Setup 182
B.11 Read Input Parameters 184
B.12 Read Previous Simulation Data 194
B.13 Output Current Simulation Data 195
B.14 Create Output Files 199
B.15 Crank-Nicholson Solver 200
B.16 Surface Evolution 201
B.17 Print to Logfile 206

C Model Derivations **208**
C.1 EBID/EBIE - Uniform Grid Spacing Derivation 208
C.1.1 Von Neumann Stability 211
C.2 EBID/EBIE - Non-Uniform Grid Spacing Derivation 216
C.3 EBIED - Derivation 219
C.3.1 Deposit Precursor Gas Concentration 219
C.3.2 Etchant Precursor Gas Concentration 221
C.3.3 Deposited Molecule Concentration 223

Bibliography **224**

List of Figures

2.1 (Figure Replicated from Hoffmann, et al.[13]) The key concepts of EBIED technique: adsorption, desorption, surface diffusion, and electron beam induced dissociation of precursor molecules. The particular precursor determines whether the resultant dissociation product causes deposition or etching. 4
2.2 (Figure Replicated from Li, et al.[16]) Schematic diagram of the potential energy as a function of the distance from the surface. 5
2.3 The electron cross section of gaseous H_2O at various electron energies [24]. 8
2.4 (Figure Replicated from Schoenaker et al.[50]) (a) Dependence of the etching depth on the etching time for several beam currents. (b) Etching rate and yield for different beam currents. The experiment was performed by using a beam energy of 2 kV. The rate and yield calculations do not take into account the peripheral etching. 11
2.5 (Figure Replicated from Choi et al.[62]) (a) Deposition of tungsten pillar under different biased conditions. (b) Scattering of electron (SE, BSE, and PE) on the tungsten pillar under different biases. 12
2.6 (Figure Replicated from Lobo, et al. [69]) (a) Growth rate plotted as a function of radius (r) from the beam axis, calculated using currents of 0.4, 0.5, 0.52, 0.53, 0.55, 0.6, 0.7, 0.8 and 1 nA. Also shown is the total electron flux profile from figure 1(d). (b) Surface plots of the 0.4, 0.5 and 0.6 nA deposition rate profiles (linear scale) ($P_d = 10^{-2}$ Pa). 15
2.7 (Figure Replicated from Bishop et al.[63]) Steady state adsorbate dissociation rates calculated using Eqs. (4)-(6) as a function of substrate temperature, and the corresponding deposition rates measured using tetraethoxysilane precursor (○). 16
2.8 (Figure Replicated from Silvis-Cividjian et al.[76]) A typical curve showing the evolution of the cone diameter. 18
2.9 (Figure Replicated from Smith et al.[74]) Normalized comparison of the MTL pillar shape, RRL pillar shape, and Gaussian beam profiles. These profiles were taken from the 1 keV MTL and RRL pillars at the same height (12.5 nm). 100 000 random Gaussian samples of a 3 nm diameter beam superimposed on the substrate surface to show the beam profile. 19
2.10 (Figure Replicated from Smith et al.[75]) Cross sections through the top 50 nm of the pillars at varying diffusion coefficients. Top row, left to right: 1.0×10^{-8}, 1.0×10^{-9}, and 1.0×10^{-10} cm^{2}s^{-1}. Bottom row, left to right: 1.0×10^{-11}, and 0.0 cm^{2}s^{-1}. 20

3.1 (Figure Replicated from Utke, et al. [4]) AFM image and line scans of FEB deposits from $Cu(hfac)_2$ precursor. Exposure times are indicated. Indented apex shapes are due to depletion. Dashed lines represent gaussian fits of each deposit. 23
3.2 (Figure Adapted from Smith, et al. [74] with a CASINO Monte Carlo simulation of electron trajectories overlayed.) 2D time-resolved cross-sectional profiles and deposition events (based on electron type) from the gas dynamics simulations. (a) Initial monolayer (ML) present (run 6). (b) Surface diffusion (run 7). (c) Surface diffusion + boundary source (run 8). The normalized sample size is 100 000 electrons. 25
3.3 Representation of three finite difference methods used to solve differential equations in time (n) and space (x): (A) Crank-Nicholson, implicit method. (B) Backward Euler, implicit method. (C) Forward Euler, explicit method. 28
3.4 Example of particle diffusion, where a single spike of concentration spreads over time due to diffusion. Each curve is 10% into the total duration of the simulation except the first curve, which is the starting condition. This example has $D = 1.0 \times 10^8$ Å/s, $\Delta x = 1.0$ Å, and $\Delta t = 1.0 \times 10^{-8}$ s with a total simulation duration of 1.0×10^{-7} seconds. 29
3.5 Example of particle diffusion, where a single spike of concentration spreads over time due to diffusion. Each curve is 10% into the total duration of the simulation except the first curve, which is the starting condition. This example has $D = 1.0 \times 10^8$ Å/s, $\Delta x = 1.0$ Å, and $\Delta t = 5.0 \times 10^{-9}$ s with a total simulation duration of 1.0×10^{-7} seconds. 30
3.6 Example of particle diffusion, where a single spike of concentration spreads over time due to diffusion. Each curve is 10% into the total duration of the simulation except the first curve, which is the starting condition. This example has $D = 1.0 \times 10^8$ Å/s, $\Delta x = 1.0$ Å, and $\Delta t = 1.0 \times 10^{-9}$ s with a total simulation duration of 1.0×10^{-7} seconds. 31
3.7 The dimensionless diffusion coefficient, D', as a function of spatial step, Δx, and time step, Δt, for a diffusion coefficient of 1.0×10^8 Å/s. The green region defines the parameter space where the dimensionless diffusion coefficient is below 0.5 and the red above 0.5. 31
3.8 The initial precursor concentration as a function of time, (A) The concentration from two separate simulations where one is EBID and the other EBIE, (B) The precursor concentration over time from a EBIED simulation. 32
3.9 (Figure Replicated from Lobo, et al. [69]) (a) Growth rate plotted as a function of radius (r) from the beam axis, calculated using currents of 0.4, 0.5, 0.52, 0.53, 0.55, 0.6, 0.7, 0.8 and 1 nA. Also shown is the total electron flux profile from figure 1(d). (b) Surface plots of the 0.4, 0.5 and 0.6 nA deposition rate profiles (linear scale) ($P_d = 10^{-2}$ Pa). 33
3.10 Comparison between the continuum component of the hybrid model used here and the continuum model published previously by Lobo et al. [69]. The EBID rates were calculated at a distance of ~ 1.5 $\mathring{A}$ from of the electron beam axis as a function of electron beam current. Both models show the same decrease in growth rate with increasing current, caused by adsorbate depletion near the beam axis. 34

3.11 (Replicated from David Joy, 1995[88]) The scattering path of an electron with the corresponding step length and angle components. 38

3.12 The original Parametric Model, where all secondary electrons generated are emitted through the closest surface bin. 41

3.13 The first modification to the Parametric Model, where all the secondary electrons generated are distributed evenly over the closest surface bins. . . . 42

3.14 The second modification to the Parametric Model, where all the secondary electrons generated are distribution evenly over the closest surface bins, however the number in each bin is modified by its solid angle to the primary electron trajectory. 42

3.15 Comparison between the Monte Carlo component of the hybrid model used here and the Monte Carlo model CASINO [80]. The dependence of the backscattered electron coefficient on electron beam energy calculated the hybrid model is in excellent agreement with that calculated by CASINO. . 44

3.16 Comparison between the secondary electron yield on a silver surface as a function of electron beam energy taken from literature data and the hybrid continuum-Monte Carlo model. 44

3.17 The secondary electron yield on a silver surface as a function of electron beam tilt. The two distinct trends are consistent with known behaviour of the depth and size of the electron beam interaction volume with beam tilt. 45

3.18 Two EBID simulations were performed for a maximum duration of 13.7 seconds, each plot is shown at different stages within the entire simulation beginning at 25% through to 100% of the maximum duration. (A) Grown without surface evolution the deposit growth direction is upwards over all space; this is confirmed in (B) where the deposit structures have been normalised. (C) Grown with surface evolution the deposit growth is in the surface normal direction; again confirmed in (D). 47

3.19 The electron flux profile (primary electrons only) from an EBID simulation with electron beam projection switched on/off. The simulation maximum duration was 13.7 seconds, and each plot is shown at different stages within the entire simulation beginning at 25% through to 100% of the maximum duration. We observe as the simulation progress the electron flux profile changes in shape to reflect the evolving surface, which would be similar to that shown in Figure 3.18. 48

3.20 The translation between the physical surface A) and the computational surface B). The physical surface is two dimensional in r & z and the computational surface is one dimensional in r, where both surfaces are radially symmetric. The path length between the points along the physical surface is, s. 49

3.21 (Figure adapted from Sobey [94]) Non-Uniform Grid Spacing Schematic. . . 51

3.22 Realistic Non-Uniform Grid Spacing Example, Schematic. 51

3.23 The first two steps of the area remapping process required to ensure correct diffusion behaviour for an evolving surface. (1) calculate the initial surface area between each point along the flat substrate; (2) calculate the surface area between each point along the now evolving nano-structure surface. An example of the calculated area between two points is highlighted in grey. . . 52

3.24 A conical frustum is defined as a cone with the tip removed, where R_1 is the base radii, R_2, is the top radii, h is the height and s is the slant height[95]. 53
3.25 A comparison of the time-evolution of the actual volume of a deposit simulated by the hybrid model, and the volume expected from the total number of molecules dissociated by electrons. The two volumes are in excellent agreement, with only minor differences of <1% observed in the residuals. . 54

4.1 EBIED Simulator Flowchart describing the general flow and order of modules. 56
4.2 Example input text file for the EBIED Simulator. 57
4.3 Example output text file for the EBIED Simulator. 59

5.1 A series of deposits shown as a function of time and temperature, with an insert depicting the typical progression of a deposit's FWHM with time. The point where the FWHM no longer increases with time is considered steady state growth. 79
5.2 Plots of $\ln(\partial h/\partial t)$ versus $1/T$ simulated using electron beam currents in the range of 0.01 pA – 1 nA in the absence of diffusion. Also shown are the corresponding straight line fits used to obtain the activation energies plotted in Figure 5.6. 80
5.3 Precursor coverage (Θ) plotted as a function of pressure (P) and substrate temperature (T) in the limit of zero electron flux ($f \rightarrow 0$). The purple region indicates the range of P and T over which the effect of Θ on Arrhenius analysis of EBID rates is negligible. 82
5.4 Activation energy obtained by Arrhenius analysis of the EBID rate ($\partial h/\partial t$) simulated at a number of temperature windows between 250 K and 450 K. The adsorption energy (E_a) of 666 meV is shown as a dashed line. The top axis shows the precursor coverage (Θ) corresponding to each temperature shown on the bottom axis. The activation energy diverges from E_a as $\Theta \rightarrow 1$. [Each datapoint was calculated from EBID rates simulated over a temperature window ΔT in the range of 20 to 50 K.] 83
5.5 Prefactors corresponding to the activation energies shown in Figure 5.4. The desorption attempt frequency (k_0) of 10^{13} Hz is shown as a dashed line. The top axis shows the precursor coverage (Θ) corresponding to each temperature shown on the bottom axis. The prefactor diverges from k_0 as $\Theta \rightarrow 1$. 84
5.6 Dependence of activation energy on beam current simulated in the absence of diffusion ($D_a = 0$) and in the presence of diffusion ($D_a = D_0 e^{-E_d/(k_B T)}$, where E_d is the diffusion energy). Also shown is a plot of adsorbate depletion ($\Theta_{r\rightarrow 0}/\Theta_{r\rightarrow\infty}$) simulated at the beam axis ($r \rightarrow 0$) in the absence of diffusion. The activation energy diverges from the adsorption energy (E_a) of 666 meV as the extent of depletion approaches 1. The precursor pressure was 0.01 Pa and the temperature was varied from 400 to 450 K. 85

6.1 Effects of diffusion on the shapes of deposits grown by EBID. (a) A series of deposits simulated as a function of temperature. At low temperatures, the deposit geometry is unaffected by diffusion, but at elevated temperatures each deposit contains a characteristic 'ring' generated by adsorbates supplied through surface diffusion. (b) Steady state vertical growth rates (R) calculated as a function of distance (r) from the electron beam axis at a number of temperatures (T_n). All simulations were performed using a Gaussian electron beam under conditions of high adsorbate depletion near the beam axis. The normalized electron flux profile $f_N(r)$ is shown as a dashed curve in (b). 92

6.2 (a) Steady state plots of the driving force of diffusion (c) versus distance (r) from the electron beam axis at a number of temperatures (T_n). Each $c(r)$ profile contains two distinct regions corresponding to the source and sink of adsorbates that diffuse along the surface and are consumed in EBID. The sink and source are separated by r_o, shown as a dashed line at 125 nm. (b) Corresponding adsorbate coverage profiles ($\Theta(r)$), and the normalized electron flux profile (($f_N(r)$, dashed grey curve). 93

6.3 (a) The fluence (C) found by integrating $c(r)$ over the sink ($0 \leq r \leq r_o$) shown in Figure 6.2(a), plotted for a number of temperatures T_n. (b,c) Corresponding plots of R_{VD} and R_{VD}/C versus T_n. The Arrhenius analysis method yields good approximations to E_D and D_o at temperatures between ~ 220 K and ~ 275 K. 95

6.4 Arrhenius plots used to generate the data in Figure 6.5(a) at temperatures (T_n) of 150, 200, 250 and 300 K. 96

6.5 (a) Activation energy (red) and pre-exponential factor (blue) obtained by Arrhenius analysis of R_{VD}/C at a number of temperatures T_n. The quantities are approximately equal to E_D and D_o (shown as dashed lines) over the temperature window $220 \lesssim T_n \lesssim 275$ K. (b) Diffusion coefficient (D) versus temperature (dashed black curve), and diffusion coefficients (red diamonds) calculated using the activation energies and pre-exponential factors in (a). . 97

6.6 The fluence C plotted as a function of electron beam current. 100

6.7 Maximum flux of diffusing adsorbates ($\max[D\nabla^2 N_a(r)]$) plotted at a number of temperatures T_n. The adsorption flux (sF) is shown as a dashed horizontal line. 102

6.8 Activation energy (red) and pre-exponential factor (blue) obtained by Arrhenius analysis of R_{VD}/C at a number of temperatures T_n. The volume $R_{VD}(T_n)$ was estimated by subtracting (a) $R(r, T_{min} = 120$ K) and (a) $R(r, T_{min} = 150$ K) from each $R(r, T_n)$ profile, and integrating the resulting curves over r. 105

List of Tables

3.1 Realistic Non-Uniform Grid Spacing Example. The fifth point was assumed to be repeated in order to calculate the required data. 51