Monte Carlo simulation is now a well-established method for studying semiconductor devices and is particularly well suited to highlighting physical mechanisms and exploring material properties. Not surprisingly, the more completely the material properties are built into the simulation, up to and including the use of a full band structure, the more powerful is the method. Indeed, it is now becoming increasingly clear that phenomena such as reliability issues related to hot-electron effects in MOSFETs cannot be understood satisfactorily without using full band Monte Carlo. The IBM simulator DAMOLES, therefore, represents a landmark of great significance. DAMOCLES sums up the totality of Monte Carlo device modeling experience of the past, and reaches with its capabilities and opportunities into the distant future. This book, therefore, begins with a description of the IBM simulator. The second chapter gives an advanced introduction to the physical basis for Monte Carlo simulations and an outlook on why complex effects such as collisional broadening and intracollisional field effects can be important and how they can be included in the simulations. References to more basic intro the book. The third chapter duty current material can be found throughout describes a typical relationship of Monte Carlo simulations to experimental data and indicates a major difficulty, the vast number of deformation potentials required to simulate transport throughout the entire Brillouin zone. The fourth chapter addresses possible further extensions of the Monte Carlo approach and subtleties of the electron-electron interaction.

Monte Carlo Modeling for Electron Microscopy and Microanalysis Oxford Series in Optical and Imaging Sciences

This book provides a thorough introduction to, and review of, the modellng of semiconductor devices using the Monte Carlo particle method. Beginning with a review of the essential physics of solid-state devices and electron transport, Dr Moglestue then explains the particle modelling technique with applications to semiconductor devices using illustrative examples from actual experience. The author draws on a wealth of experience in the field to provide a tutorial and reference source for device physicists, electronics engineers and graduate students wishing to apply Monte Carlo techniques.

This work establishes a framework for Monte Carlo simulations of complex, modulated electron fields produced by Varian’s TrueBeam medical linear accelerator for investigations into modulated electron radiation therapy (MERT) and combined modulated photon and electron radiation therapy (MPERT). Both MERT and MPERT have shown potential for reduced low dose to normal tissue without compromising target control. In the external beam radiation therapy of some breast, chest wall, head and neck, and scalp cancers. The reduction in low dose could translate into the reduction of immediate radiation side effects as well as long term morbidities and incidence of secondary cancers. Monte Carlo dose calculations are widely accepted as the gold standard for complex radiation therapy dose modelling, and are used almost exclusively for modelling the complex electron fields involved in MERT and MPERT. The introduction of Varian’s newest linear accelerator, the TrueBeam, necessitated the development of new Monte Carlo models in order to further research into the potential role of MERT and MPERT in radiation therapy. This was complicated by the fact that the field independent internal schematics of TrueBeam were kept proprietary, unlike in previous generations of Varian accelerators. Two approaches are presented for performing Monte Carlo simulations of complex electron fields produced by TrueBeam. In the first approach, the dosimetric characteristics of electron fields produced by the TrueBeam were first compared with those produced by an older Varian accelerator, the Clinac 21EX. Differences in depth and profile characteristics of fields produced by the TrueBeam and those produced by the Clinac 21EX were found to be within 3%/3 mm. Given this information, complete accelerator models of the Clinac 21EX, based on its known internal geometry, were then successfully modified in order to simulate 12 and 20 MeV electron fields produced by the TrueBeam to within 2%/2 mm of measured depth and profile curves and to within 3.7% of measured relative output. While the 6 MeV TrueBeam model agreed with measured depth and profile data to within 3%/3 mm, the modified Clinac 21EX model was unable to reproduce trends in relative output as a function of fieldsize with acceptable accuracy. The second approach to modelling TrueBeam electron fields used phase-space source files provided by Varian that were scored below the field-independent portions of the accelerator head geometry. These phase-spaces were first validated for use in MERT and MPERT applications, in which simulations using the phase-space source files were shown to model depth dose curves that agreed with measurement within 2%/2 mm and profile curves that agreed with measurement within 3%/3 mm. Simulated changes in output as a function of field size fell within 2.7%, for the most part. In order to inform the positioning of jaws in MLC-shaped electron field delivery, the change in output as a function of jaw position for fixed MLC-apertures was investigated using the phase-space source files. In order to achieve maximum output and minimize treatment time, a jaw setting between 5 and 10 cm beyond the MLC-field setting is recommended at 6 MeV, while 5 cm or closer is recommended for 12 and 20 MeV with the caveat that output is most sensitive to jaw position when the jaws are very close to the MLC-field periphery. Additionally, output was found to be highly sensitive to jaw model. A change in divergence of the jaw faces from a point on the source plane to a 3x3 mm² square in the source plane changed the shape of the output curve dramatically. Finally, electron backscatter from the jaws into the monitor ionization chamber of the TrueBeam was measured and simulated to enable accurate absolute dose calculations. Two approaches were presented for measuring backscatter into the monitor ionization chamber without specialized electronics by turning o the dose and pulse forming network servos. Next, a technique was applied for simulating backscatter factors for the TrueBeam phase-space source models without the exact specifications of the monitor ionization chamber. By using measured backscatter factors, the forwarddose component in a virtual chamber was determined and then used to calculate backscatter factors for arbitrary fields to within 0.21%. Backscatter from the jaws was found to contribute up to 2.6% of the overall monitor chamber signal. The measurement techniques employed were not sensitive enough to quantify backscatter from the MLC, however, Monte Carlo simulations predicted this contribution to be 0.3%, at most, verifying that this component can be neglected.

Transport of Energetic Electrons in Solids

Proefschrift
Penelope
Monte Carlo and Density Functional Theory Simulation of Electron Energy Loss Spectra
Monte Carlo Simulation of Electron Swarms in
Monte Carlo Simulations of Electron Transport in Quantum Well Heterostructures
Monte Carlo Modeling for Electron Microscopy and Microanalysis
Ensemble Monte Carlo simulation of electron transport in AlGaAs/GaAs heterostructures
Analysis of Electron Heat Transfer Via Monte Carlo Simulation
Monte Carlo Device Modeling Applications on Parallel Computers

A 3D model of a low voltage electron beam has been constructed using the ITS/ACCEPT Monte Carlo code in order to validate the code for this application and improve upon 1D slab geometry simulations. A line source description update to the code allows complete simulation of a
low voltage electron beam with any filament length. Faithful reproduction of the geometric elements involved, especially the window support structure, can account for 90–95% of the dose received by routine dosimetry. With a 3D model, dose distributions in non-web articles can be computed and effects of equipment modifications can be anticipated in advance.

Response Matrix Monte Carlo Based on a General Geometry Local Calculation for Electron Transport

A Monte Carlo Simulation of Electron Dynamics in Laser-excited Liquid Water

Monte Carlo Simulation of the Electron-solid Interaction with Emphasis on Scanning Electron Microscopy

Monte Carlo Simulation of Electron Transport Process in GaAs

Monte Carlo Simulation in Electron Microscopy and Spectroscopy

A Code System for Monte Carlo Simulation of Electron-photon Showers

A Monte Carlo Simulation of Electron Irradiation of Complex Objects

Experimental Validation and Evaluation of Uncertainty in the Monte Carlo Modeling of Electron Irradiation of Complex Objects

Monte Carlo Simulation of Electron Beam Scattering and Energy Loss in Thin Films on Thick Substrates

Electron-Beam Interactions with Solids

Low energy electron beam interactions with solid materials. Low energy electron beam interactions with solid materials. Low energy electron beam interactions with solid materials. Low energy electron beam interactions with solid materials. Low energy electron beam interactions with solid materials. Low energy electron beam interactions with solid materials.
A Response Matrix Monte Carlo (RMMC) method has been developed for solving electron transport problems. This method was born of the need to have a reliable, computationally efficient transport method for low energy electrons (below a few hundred keV) in all materials. Today, condensed history methods are used which reduce the computation time by modeling the combined effect of many collisions but fail at low energy because of the assumptions required to characterize the electron scattering. Analog Monte Carlo simulations are prohibitively expensive since electrons undergo coulombic scattering with little state change after a collision. The RMMC method attempts to combine the accuracy of an analog Monte Carlo simulation with the speed of the condensed history methods. The combined effect of many collisions is modeled, like condensed history, except it is precalculated via an analog Monte Carlo simulation. This avoids the scattering kernel assumptions associated with condensed history methods. Results show good agreement between the RMMC method and analog Monte Carlo. 11 refs., 7 figs., 1 tabs. Modeling ion beam induced secondary electron (iSE) production within matter for simulating ion beam induced images has been studied. When the complex nature of ion beam interactions with matter is accounted for, a detailed quantitative model of the ion interactions with matter, Monte Carlo simulation will be the best choice to be able to compute and predict iSE yields faster and more accurately. In order to build Monte Carlo simulation software incorporated with a reliable database of stopping power tables, for wide variety of range of materials, there have been numerous attempts to experimentally measure ion stopping power tables and to tabulate the data. Experimental data for pure elements and compounds is almost totally absent and the ability of advanced software to calculate iSE production within matter for producing reliable predictions is limited. Despite the need having a complete set of experimental ion stopping power tables will not be easily obtained for at least several decades. This study explores the incorporation of a universal stopping power curve, calculated and published by the National Institute of Standards and Technology at Boulder, into a Monte Carlo simulation software that will be able to compute iSE yield for both pure elements and compounds. This new approach of modeling iSE generations for pure elements and compounds will contribute to quantify performance of the helium ion microscope and other ion microscopes. The interaction of an electron beam with a solid target has been studied since the early part of the past century. Since 1960, the electron–solid interaction has become the subject of a number of investigators’ work owing to its fundamental role in scanning electron microscopy, in electron-probe microanalysis, in Auger electron spectroscopy, in electron-beam lithography and in radiation damage. The interaction of an electron beam with a solid target has often been investigated theoretically by using the Monte Carlo method, a numerical procedure involving random numbers that is able to solve mathematical problems. This method is very useful for the study of electron penetration in matter. The probabilistic laws of the interaction of an individual electron with the atoms constituting the target are well known. Consequently, it is possible to compute the macroscopic characteristics of interaction processes by simulating a large number of real trajectories, and then averaging them. The aim of this book is to study the probabilistic laws of the interaction of individual electrons with atoms (elastic and inelastic cross-sections); to generate selected aspects of electron interaction with matter (backscattering coefficients for bulk targets, absorption, backscattering and transmission for both supported and unsupported thin films, implantation profiles, secondary electron emission, and so on); and to introduce the Monte Carlo method and its applications to compute the macroscopic characteristics of the interaction processes mentioned above. The book compares theory, computational simulations and experimental data in order to offer a more global vision. This new edition describes all the mechanisms of elastic and inelastic scattering of electrons with the atoms of the target as simple as possible. The use of techniques of quantum mechanics is described in detail for the investigation of interaction processes of electrons with matter. It presents the strategies of the Monte Carlo method, as well as numerous comparisons among the results of the simulations and the experimental data available in the literature. New in this edition is the description of the Mermin theory, a comparison between Mermin theory and Drude theory, a discussion about the dispersion laws, and details about the calculation of the phase shifts that are used in the relativistic partial wave expansion method. The role of secondary electrons in proton cancer therapy is discussed in the chapter devoted to applications. In this context, Monte Carlo results about the radial distribution of the energy deposited in PMMA by secondary electrons generated by energetic proton beams are presented.
Carlo simulations are prohibitively expensive since electrons undergo coulombic scattering with little state change after a collision. The RMMC method attempts to combine the accuracy of an analog Monte Carlo simulation with the speed of the condensed history methods. Like condensed history, the RMMC method uses probability distributions functions (PDFs) to describe the energy and direction of the electron after several collisions. However, unlike the condensed history method the PDFs are based on an analog Monte Carlo simulation over a small region. Condensed history theories require assumptions about the electron scattering to derive the PDFs for direction and energy. Thus the RMMC method samples from PDFs which more accurately represent the electron random walk. Results show good agreement between the RMMC method and analog Monte Carlo. 13 refs., 8 figs.

"The scope of this thesis is the study of electron transportation and electron energy loss spectra using Monte Carlo and density functional theory calculations. In the first part, the electron transportations in the bulk materials and thin solid films were studied using Monte Carlo simulations based on the optical data model. The optical data model gives the benefit of the calculations of the backscattering and transmission coefficients from very low (about 100 eV) to high (about 500 keV) beam energies. The simulation results for backscattering and transmission coefficients are in good agreement with the available experimental data. Based on the Monte Carlo simulation results a new relation between backscattering and transmission coefficients of thin solid films was suggested enabling the estimation of one coefficient by having the other coefficient. A universal form for the signal-to-background ratio and the signal-to-noise ratio versus thickness divided by the inelastic mean free path was observed by Monte Carlo simulations in agreement with the available theoretical models. In addition, a simple equation was suggested for the estimation of the optimum thickness for the highest amount of signal-to-noise ratio. The equation implies that by having the value of one optimum thickness at a given beam energy the optimum thicknesses at other beam energies can be estimated. In the second part of the thesis, the fine structure of energy-loss near-edge structure (ELNES) obtained by the density functional theory calculations was introduced to the Monte Carlo simulations of the electron energy loss spectra. Density functional theory calculations successfully predicted the shape of energy-loss near-edge in comparison with the experimental measurements. Based on the suggested approach, the fine structure of an ionization edge can be introduced to the optical oscillator strength instead of the X-ray photoelectric data. X-ray photoelectric data does not contain the solid state effects and is appropriate for single atoms only. As a result of this approach, the total X-ray absorption coefficient can be calculated including the fine structure of inner-shell ionization edges. Using the Monte Carlo simulations with the new optical oscillator strength containing the fine structure of ionization edges, effect of different parameters of background removal for the ionization edges was studied. Monte Carlo simulations provided the optimum values for the optimization of the signal-to-background ratio calculations. In the third part of thesis, effect of temperature and pressure on the low-loss region of energy loss function were investigated. The energy loss function is in the direct relationship with the optical oscillator strength; hence it is important to study the parameters affecting the energy loss function. The density functional theory calculations were performed based on the change in the lattice parameter variation of solids with temperature and pressure. The results of density functional theory calculations are in good agreement with the experimental temperature dependency of plasmon energy of aluminum. In addition, a new model for the temperature and pressure dependency of the plasmon energy of solids was suggested by combination of the free electron model and the pseudo-spinodal equation of state. The results of suggested model are in good agreement with the results of density function theory calculations. As well, the departure from the free electron behavior at high pressures was confirmed from the results of density functional theory calculations."

Monte Carlo Simulation of Real-Space Electron Transfer in GaAs-AlGaAs Heterostructure
Complete Model Description of an Electron Beam Using ACCEPT Monte Carlo Simulation Code
The Monte Carlo Method for Semiconductor Device Simulation
Detailed Monte Carlo Simulation of Electron Elastic Scattering
Monte Carlo Simulation of Electron Transport in a Helium Gas
Monte Carlo Simulation of Radiative Processes in Electron-positron Scattering