

SUPERCONDUCTING ELECTRON-OPTIC DEVICES

I. Dietrich

Superconducting Electron Optic Devices

E.W. Collings



Superconducting Electron Optic Devices:

Superconducting Electron-Optic Devices I. Dietrich, 2012-12-06 Electron optics involves the influence of electric and magnetic fields on electron beams In those electron optical instruments utilizing magnetic fields a replacement of the conventional i.e. nonsuperconducting electron optical parts is worth considering if the outstanding magnetic properties of superconductors can improve the systems However the use of superconductors demands complicated cryogenic techniques and this of course dampens enthusiasm There are fields however where there are extreme requirements on the optical systems namely electron microscopy and high energy physics The great advantage of the combination of electron optics and superconductivity in these domains has been demonstrated in recent experiments This monograph is mainly concerned with electron microscopy Superconductivity in high energy electron optics is treated only briefly in Appendix A since the author is little acquainted with the details of the projects Furthermore the number of experiments as yet carried out is small In Appendix B electron microscope studies of basic superconductor phenomena are reviewed This material is included even though it is only slightly connected with the main topic of the book since a breakthrough in this field may be possible by the application of superconducting lenses Superconducting Devices & Materials, 1972 Principles of Electron Optics Peter W. Hawkes, Erwin Kasper, 2012-12-02 This is a complete handbook and reference volume which covers everything that one needs to know about electron optics It is a comprehensive coverage of theoretical background and modern computing methods It contains a detailed and unique account of numerical methods and an extensive bibliography *Principles of Electron Optics, Volume 2* Peter W. Hawkes, Erwin Kasper, 2017-12-13 *Principles of Electron Optics Applied Geometrical Optics* Second Edition gives detailed information about the many optical elements that use the theory presented in Volume 1 electrostatic and magnetic lenses quadrupoles cathode lens based instruments including the new ultrafast microscopes low energy electron microscopes and photoemission electron microscopes and the mirrors found in their systems Wien filters and deflectors The chapter on aberration correction is largely new The long section on electron guns describes recent theories and covers multi column systems and carbon nanotube emitters Monochromators are included in the section on curved axis systems The lists of references include many articles that will enable the reader to go deeper into the subjects discussed in the text The book is intended for postgraduate students and teachers in physics and electron optics as well as researchers and scientists in academia and industry working in the field of electron optics electron and ion microscopy and nanolithography Offers a fully revised and expanded new edition based on the latest research developments in electron optics Written by the top experts in the field Covers every significant advance in electron optics since the subject originated Contains exceptionally complete and carefully selected references and notes Serves both as a reference and text

Electron and Ion Optics Miklos Szilagyi, 2012-12-06 The field of electron and ion optics is based on the analogy between geometrical light optics and the motion of charged particles in electromagnetic fields The spectacular development

of the electron microscope clearly shows the possibilities of image formation by charged particles of wavelength much shorter than that of visible light As new applications such as particle accelerators cathode ray tubes mass and energy spectrometers microwave tubes scanning type analytical instruments heavy beam technologies etc emerged the scope of particle beam optics has been extended to the formation of fine probes The goal is to concentrate as many particles as possible in as small a volume as possible Fabrication of microcircuits is a good example of the growing importance of this field The current trend is towards increased circuit complexity and pattern density Because of the diffraction limitation of processes using optical photons and the technological difficulties connected with x ray processes charged particle beams are becoming popular With them it is possible to write directly on a wafer under computer control without using a mask Focused ion beams offer especially great possibilities in the submicron region Therefore electron and ion beam technologies will most probably play a very important role in the next twenty years or so

Principles of Electron Optics, Volume 1 Peter W. Hawkes, Erwin Kasper, 2017-10-29 Volume one of Principles of Electron Optics Basic Geometrical Optics Second Edition explores the geometrical optics needed to analyze an extremely wide range of instruments cathode ray tubes the family of electron microscopes including the fixed beam and scanning transmission instruments the scanning electron microscope and the emission microscope electron spectrometers and mass spectrograph image converters electron interferometers and diffraction devices electron welding machines and electron beam lithography devices The book provides a self contained detailed modern account of electron optics for anyone involved with particle beams of modest current density in the energy range up to a few mega electronvolts You will find all the basic equations with their derivations recent ideas concerning aberration studies extensive discussion of the numerical methods needed to calculate the properties of specific systems and guidance to the literature of all the topics covered A continuation of these topics can be found in volume two Principles of Electron Optics Applied Geometrical Optics The book is intended for postgraduate students and teachers in physics and electron optics as well as researchers and scientists in academia and industry working in the field of electron optics electron and ion microscopy and nanolithography Offers a fully revised and expanded new edition based on the latest research developments in electron optics Written by the top experts in the field Covers every significant advance in electron optics since the subject originated Contains exceptionally complete and carefully selected references and notes Serves both as a reference and text

Principles of Electron Optics P. W. Hawkes, E. Kasper, Erwin Kasper, 1996 Magnetic Electron Lenses P.W. Hawkes, 2013-11-11 No single volume has been entirely devoted to the properties of magnetic lenses so far as I am aware although of course all the numerous textbooks on electron optics devote space to them The absence of such a volume bringing together in formation about the theory and practical design of these lenses is surprising for their introduction some fifty years ago has created an entirely new family of commercial instruments ranging from the now traditional transmission electron microscope through the reflection and transmission scanning microscopes to columns for

micromachining and microlithography not to mention the host of experimental devices not available commercially. It therefore seemed useful to prepare an account of the various aspects of magnetic lens studies. These divide naturally into the five chapters of this book: the theoretical background in which the optical behaviour is described and formulae given for the various aberration coefficients; numerical methods for calculating the field distribution and trajectory tracing; extensive discussion of the paraxial optical properties and aberration coefficients of practical lenses illustrated with curves from which numerical information can be obtained; a complementary account of the practical engineering aspects of lens design including permanent magnet lenses and the various types of superconducting lenses; and finally an up to date survey of several kinds of highly unconventional magnetic lens which may well change the appearance of future electron optical instruments very considerably after they cease to be unconventional.

Transmission Electron Microscopy Ludwig Reimer, 2013-11-11. Transmission Electron Microscopy presents the theory of image and contrast formation and the analytical modes in transmission electron microscopy. The principles of particle and wave optics of electrons are described. Electron specimen interactions are discussed for evaluating the theory of scattering and phase contrast. Also discussed are the kinematic and dynamical theories of electron diffraction and their applications for crystal structure analysis and imaging of lattices and their defects. X-ray microanalysis and electron energy loss spectroscopy are treated as analytical methods. This fourth edition includes discussions of recent progress especially in the area of Schottky emission guns, convergent beam electron diffraction, electron tomography, holography and the high resolution of crystal lattices.

High-Resolution Electron Microscopy John C. H. Spence, 2013-09-12. This new fourth edition of the standard text on atomic resolution transmission electron microscopy (TEM) retains previous material on the fundamentals of electron optics and aberration correction, linear imaging theory including wave aberrations to fifth order with partial coherence and multiple scattering theory. Also preserved are updated earlier sections on practical methods with detailed step by step accounts of the procedures needed to obtain the highest quality images of atoms and molecules using a modern TEM or STEM electron microscope. Applications sections have been updated; these include the semiconductor industry, superconductor research, solid state chemistry and nanoscience and metallurgy, mineralogy, condensed matter physics, materials science and material on cryo electron microscopy for structural biology. New or expanded sections have been added on electron holography, aberration correction, field emission guns, imaging filters, super resolution methods, Ptychography, Ronchigrams, tomography, image quantification and simulation, radiation damage, the measurement of electron optical parameters and detectors, CCD cameras, image plates and direct injection, solid state detectors. The theory of Scanning transmission electron microscopy (STEM) and Z contrast are treated comprehensively. Chapters are devoted to associated techniques such as energy loss spectroscopy, Alchemi nanodiffraction, environmental TEM, twisty beams for magnetic imaging and cathodoluminescence. Sources of software for image interpretation and electron optical design are given.

Selected Papers on Electron Optics P. W. Hawkes, 1994.

Cryocoolers Graham Walker, 2012-12-06 The rapidly expanding use of very low temperatures in research and high technology during the last several decades and the concurrent high degree of activity in cryogenic engineering have mutually supported each other each improvement in refrigeration technique making possible wider opportunities for research and each new scientific discovery creating a need for a refrigerator with special features In this book Professor Walker has provided us with an excellent exposition of the achievements of this period the fundamental principles involved and a critical examination of the many different cryogenic systems which have led to a new era of low level refrigeration I feel fortunate to have had a part in the developments discussed in this book During the early 1930s I constructed several rotary engines using leather vanes Their performance was not good but I was able to liquefy air I had been impressed by the usefulness of leather cups in tire pumps and in Claude type engines for air liquefaction I was trying to find a way to avoid that part of the friction generated by a leather cup as a result of the radial force of the working gas on the cylindrical part of the cup During the 1950s I built two efficient helium liquefiers in which essentially leather pistons were used

Polymer Properties at Room and Cryogenic Temperatures Gunther Hartwig, 2013-04-18 Most descriptions of polymers start at room temperature and end at the melting point This textbook starts at very low temperatures and ends at room temperature At low temperatures many processes and relaxations are frozen which allows singular processes or separate relaxations to be studied At room temperatures or at the main glass transitions many processes overlap and the properties are determined by relaxations At low temperatures there are temperature ranges with negligible influences by glass transitions They can be used for investigating so called basic properties which arise from principles of solid state physics The chain structure of polymers however requires stringent modifications for establishing solid state physics of polymers Several processes which are specific of polymers occur only at low temperatures There are also technological aspects for considering polymers at low temperatures More and more applications of polymeric materials in low temperature technology appear Some examples are thermal and electrical insulations support elements for cryogenic devices low loss materials for high frequency equipments It is hoped that in addition to the scientific part a data collection in the appendix may help to apply polymers more intensively in low temperature technology The author greatly appreciates the contributions by his coworkers of the

Kernforschungszentrum Karlsruhe in measurement and discussion of many data presented in the textbook and its appendix Fruitful discussions with the colleagues Prof H Baur Prof S Hunklinger Prof D Munz and Prof R

Applied Superconductivity, Metallurgy, and Physics of Titanium Alloys E.W. Collings, 2013-03-07 Scope and Purpose Although conductors based on the Al₅ intermetallic compound Nb₃Sn possess desirable high field superconducting properties manufacturing and handling difficulties coupled with the tendency of their critical current densities to degrade rapidly under stress have generally restricted their use to fairly straightforward usually small scale solenoidal magnet applications Likewise the Al₅ compound VGa which has a wider critical strain window than Nb₃Sn but a uniformly lower upper critical

field has not entered widespread service Strain has been found to have no measurable influence on either the critical fields or the critical current densities of compound superconductors with BI and Cl5 crystal structures but as yet they are still in the research and development stages On the other hand conductors using the binary alloy Ti Nb or multi component alloys based on it because of their relative ease of manufacture excellent mechanical properties and relatively low strain sensitivities are now being pressed into service in numerous large scale devices Such conductors are being wound into magnets for use in energy storage energy conversion i e generators and motors and high energy particle detectors and beam handling magnets of cold rolled or drawn Ti Nb alloy wire for superconducting The use magnet applications was first proposed in 1961 During the ensuing ten years while progress was being made in the development of Cu clad filamentary Ti Nb alloy conductors Ti Nb and other Ti base binary transition metal TM alloys were being employed as model systems in the fundamental study of type II superconductivity

Cryogenic Process Engineering Klaus D. Timmerhaus, Thomas M. Flynn, 2013-06-29 Cryogenics a term commonly used to refer to very low temperatures had its beginning in the latter half of the last century when man learned for the first time how to cool objects to a temperature lower than had ever existed naturally on the face of the earth The air we breathe was first liquefied in 1883 by a Polish scientist named Olszewski Ten years later he and a British scientist Sir James Dewar liquefied hydrogen Helium the last of the so called permanent gases was finally liquefied by the Dutch physicist Kamerlingh Onnes in 1908 Thus by the beginning of the twentieth century the door had been opened to a strange new world of experimentation in which all substances except liquid helium are solids and where the absolute temperature is only a few microdegrees away However the point on the temperature scale at which refrigeration in the ordinary sense of the term ends and cryogenics begins has never been well defined Most workers in the field have chosen to restrict cryogenics to a temperature range below 150 C 123 K This is a reasonable dividing line since the normal boiling points of the more permanent gases such as helium hydrogen neon nitrogen oxygen and air lie below this temperature while the more common refrigerants have boiling points that are above this temperature Cryogenic engineering is concerned with the design and development of low temperature systems and components

Cryogenic Engineering Klaus D. Timmerhaus, Richard P. Reed, 2007-11-12 Cryogenic Engineering Fifty Years of Progress is a benchmark reference work which chronicles the major developments in the field Starting with an historical background dating to the 1850s this book reviews the development of data resources now available for cryogenic fields and properties of materials The advances in cryogenic fundamentals are covered by reviews of cryogenic principles cryogenic insulation low loss storage systems modern liquefaction processes helium cryogenics and low temperature thermometry Several well established applications resulting from cryogenic advances include aerospace cryocoolers and refrigerators use of LTS and HTS systems in electrical applications and recent changes in cryopreservation Extensive references are provided for the readers interested in the details of these cryogenic engineering advances

Thermodynamic Properties of Cryogenic Fluids Richard T.

Jacobsen, Steven G. Penoncello, Eric W. Lemmon, 2013-11-22 Practicing engineers and scientist will benefit from this book's presentation of the most accurate information on the subject. The equations for fifteen important cryogenic fluids are presented in a basic format accompanied by pressure enthalpy and temperature entropy charts and tables of thermodynamic properties. The book is supported by ICMPROPERS, an interactive computer program for the calculation of thermodynamic properties of the cryogenic fluids that can be downloaded from the World Wide Web. **Cryogenic Engineering** Mr. Rohit Manglik, 2024-05-04 EduGorilla Publication is a trusted name in the education sector committed to empowering learners with high quality study materials and resources. Specializing in competitive exams and academic support, EduGorilla provides comprehensive and well structured content tailored to meet the needs of students across various streams and levels.

Cryogenic Regenerative Heat Exchangers Robert A. Ackermann, 2013-11-21 An in depth survey of regenerative heat exchangers, this book chronicles the development and recent commercialization of regenerative devices for cryogenic applications. Chapters cover historical background, concepts, practical applications, design data and numerical solutions, providing the latest information for engineers to develop advanced cryogenic machines. The discussions include insights into the operation of a regenerator, descriptions of the cyclic and fluid temperature distributions in a regenerator, data for various matrix geometries and materials including coarse and fine bronze, stainless steel, woven wire mesh screens and lead spheres, and unique operating features of cryocoolers that produce deviations from ideal regenerator theory. *Modern Gas-Based Temperature and Pressure Measurements* Franco Pavese, Gianfranco Molinar, Min Beciet, 2013-06-29 Since the beginning of the preparation of this volume, we have been convinced that temperature and pressure measurements should not be separated, particularly in different applications at low temperatures. This belief has made us deeply conscious of the fact that the advanced applications and modern experimental methods of investigation in science and technology need the combination of various professional experiences and approaches. Although the book is divided into two parts, Part I by F Pavese and Part II by G F Molinar, we have tried to correlate low temperature and low pressure measurements as much as possible. We hope that our readers will find this book, which contains a large number of experimental and reference data, useful in their effort to solve measurement problems. We are pleased to acknowledge our debt to several persons and wish to express our gratitude to them for their valuable cooperation and help to our research group colleagues at the Istituto di Metrologia G. Colonnetti, IMGC, CNR, without whom the knowledge and the experience we built up during many years could not have been acquired. To G. T. McConville, M. Durieux and K. Grohmann for revisions of and various suggestions for Part I, to V. E. Bean and C. R. Tilford of NIST and G. T. McConville for revisions of and various suggestions for Part II, and to I. Prinetti of IMGC for many valuable suggestions and careful textual revisions.

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