

Article

Spectra of Low Energy Electrons Emitted in the Interaction of Slow Ne⁺ Ions with Mg Surfaces

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Abstract: We measured spectra of low energy electrons emitted in the interaction of singly charged Ne⁺ ions with the Mg surface at incident ion energies ranging from 50 eV to 4 keV. The study examines issues related to the excitation of both the surface and the bulk plasmons of the target. We will also focus on the dynamics of the production of the singlet Ne2p⁴(¹D)3s² and triplet Ne2p⁴(³P)3s² autoionizing states of projectiles scattered in a vacuum. The threshold behavior of the autoionization lines show that double excitation occurs simultaneously in a single scattering. The predominant excitation of the triplet state indicates the importance of charge rearrangement and the electron correlation effects during the collisional excitation.

Keywords: surface scattering; autoionization and Auger processes; plasmons; electron emission

1. Introduction

Electron emission is a fundamental consequence of the interaction of charged particles with the surfaces of solids and is of crucial importance in many applications, such as electrical discharge, spectroscopic techniques for the characterization of materials, as well as microscopy. Advances in all these research areas call for an improved understanding of electronic excitation and energy deposition and conversion processes in solids [1–3]. Two quantities are measured in studies of electron emission as a function of several variables, such as impact energy, incidence and emission angles, surface conditions, etc. These are the energy distributions of emitted electrons and their integrals, the electron emission yield. Knowledge of the yield, i.e., the number of electrons emitted per incident projectile, is generally required for these applications, while studies of the energy distribution of emitted electrons give information on specific emission phenomena, which are individuated by their characteristic spectral signatures. In the case of atomic projectiles, since they carry both potential and kinetic energy, a traditional classification divides electron emission phenomena into two main categories, namely that of potential electron emission and that of kinetic electron emission [1,4–11]. For potential electron emission (PEE) [1,4–7], the potential energy stored in the excited or ionized states of the projectiles is converted into electron excitation and emission by charge transfer processes between the projectile and the surface. The energy conversion occurs through non-local resonant and/or Auger processes that occur outside the surface and involve the electronic structure of the solid surface. Resonant charge transfer does not give origin to electron emission directly but can be the precursor of an Auger deexcitation process. Moreover, resonant processes can determine the charge and excitation state of impinging particles, which in turn determines the excitation process during a subsequent binary atomic collision. For example, according to the taxonomy introduced by Hagstrum [4], an incoming ion can be neutralized via Auger neutralization (AN), which involves two electrons from the solid surface, or via an interatomic Auger deexcitation following the resonant capture of an electron from the solid



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Low Energy Electron Spectrometry

Didier Musso

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Low Energy Electron Spectrometry Kenneth D. Sevier, 1972 **Auger Electron Spectroscopy** Donald T.

Hawkins, 2012-12-06 Auger electron spectroscopy is rapidly developing into the single most powerful analytical technique in basic and applied science for investigating the chemical and structural properties of solids. Its explosive growth beginning in 1967 was triggered by the development of Auger analyzers capable of detecting one atom layer of material in a fraction of a second. Continued growth was guaranteed firstly by the commercial availability of apparatus which combined the capabilities of scanning electron microscopy and ion mill depth profiling with Auger analysis and secondly by the increasing need to know the atomistics of many processes in fundamental research and engineering applications. The expanding use of Auger analysis was accompanied by an increase in the number of publications dealing with it. Because of the developing nature of Auger spectroscopy the articles have appeared in many different sources covering diverse disciplines so that it is extremely difficult to discover just what has or has not been subjected to Auger analysis. In this situation a comprehensive bibliography is obviously useful to those both inside and outside the field. For those in the field this bibliography should be a wonderful time saver for locating certain references in researching a particular topic or when considering various aspects of instrumentation or data analysis. This bibliography not only provides the most complete listing of references pertinent to surface Auger analysis available today but it is also a basis for extrapolating from past trends to future expectations.

Low-Energy Electron Diffraction Michel A. VanHove, William Henry Weinberg, Chi-Ming Chan, 2012-12-06 Surface crystallography plays the same fundamental role in surface science which bulk crystallography has played so successfully in solid state physics and chemistry. The atomic scale structure is one of the most important aspects in the understanding of the behavior of surfaces in such widely diverse fields as heterogeneous catalysis, microelectronics, adhesion, lubrication, corrosion, coatings, and solid-solid and solid-liquid interfaces. Low Energy Electron Diffraction or LEED has become the prime technique used to determine atomic locations at surfaces. On one hand LEED has yielded the most numerous and complete structural results to date, almost 200 structures, while on the other LEED has been regarded as the technique to beat by a variety of other surface crystallographic methods such as photoemission, SEXAFS, ion scattering, and atomic diffraction. Although these other approaches have had impressive successes, LEED has remained the most productive technique and has shown the most versatility of application from adsorbed rare gases to reconstructed surfaces of semiconductors and metals to molecules adsorbed on metals. However, these statements should not be viewed as excessively dogmatic since all surface sensitive techniques retain untapped potentials that will undoubtedly be explored and exploited. Moreover, surface science remains a multi-technique endeavor. In particular, LEED never has been and never will be self-sufficient. LEED has evolved considerably and in fact has reached a watershed. *Surface Microscopy with Low Energy Electrons* Ernst Bauer, 2014-07-10 This book written by a pioneer in surface physics and thin film research and the inventor of Low Energy Electron Microscopy (LEEM)

Spin Polarized Low Energy Electron Microscopy SPLEEM and Spectroscopic Photo Emission and Low Energy Electron Microscopy SPELEEM covers these and other techniques for the imaging of surfaces with low energy slow electrons These techniques also include Photoemission Electron Microscopy PEEM X ray Photoemission Electron Microscopy XPEEM and their combination with microdiffraction and microspectroscopy all of which use cathode lenses and slow electrons Of particular interest are the fundamentals and applications of LEEM PEEM and XPEEM because of their widespread use Numerous illustrations illuminate the fundamental aspects of the electron optics the experimental setup and particularly the application results with these instruments Surface Microscopy with Low Energy Electrons will give the reader a unified picture of the imaging diffraction and spectroscopy methods that are possible using low energy electron microscopes **The Physics of Micro/Nano-Fabrication** Ivor Brodie, Julius J. Murray, 2013-06-29 In this revised and expanded edition the authors provide a comprehensive overview of the tools technologies and physical models needed to understand build and analyze microdevices Students specialists within the field and researchers in related fields will appreciate their unified presentation and extensive references Electron Microscopy S. Amelinckx, Dirk van Dyck, J. van Landuyt, Gustaaf van Tendeloo, 2008-09-26 Derived from the successful three volume Handbook of Microscopy this book provides a broad survey of the physical fundamentals and principles of all modern techniques of electron microscopy This reference work on the method most often used for the characterization of surfaces offers a competent comparison of the feasibilities of the latest developments in this field of research Topics include Stationary Beam Methods Transmission Electron Microscopy Electron Energy Loss Spectroscopy Convergent Electron Beam Diffraction Low Energy Electron Microscopy Electron Holographic Methods Scanning Beam Methods Scanning Transmission Electron Microscopy Scanning Auger and XPS Microscopy Scanning Microanalysis Imaging Secondary Ion Mass Spectrometry Magnetic Microscopy Scanning Electron Microscopy with Polarization Analysis Spin Polarized Low Energy Electron Microscopy Materials scientists as well as any surface scientist will find this book an invaluable source of information for the principles of electron microscopy **Bibliography of Mass Spectroscopy Literature for 1971**, 1973 **Handbook of Spectroscopy** Günter Gauglitz, David S. Moore, 2014-05-05 This second thoroughly revised updated and enlarged edition provides a straightforward introduction to spectroscopy showing what it can do and how it does it together with a clear integrated and objective account of the wealth of information that may be derived from spectra It also features new chapters on spectroscopy in nano dimensions nano optics and polymer analysis Clearly structured into sixteen sections it covers everything from spectroscopy in nanodimensions to medicinal applications spanning a wide range of the electromagnetic spectrum and the physical processes involved from nuclear phenomena to molecular rotation processes In addition data tables provide a comparison of different methods in a standardized form allowing readers to save valuable time in the decision process by avoiding wrong turns and also help in selecting the instrumentation and performing the experiments These four volumes are a must have companion

for daily use in every lab *Vibrational Spectroscopy of Molecules on Surfaces* Theodore E. Madey, John T. Yates Jr., 2013-11-11 The observation of the vibrational spectra of adsorbed species provides one of the most incisive methods for understanding chemical and physical phenomena on surfaces At the present time many approaches may be applied to studies of molecular vibrations on surfaces Some of these are used on high area solids of technological importance e g heterogeneous catalysts while others are applied to single crystal substrates to gain better understanding under conditions of controlled surface structure This book has attempted to bring together in one place a discussion of the major methods used to measure vibrational spectra of surface species The emphasis is on basic concepts and experimental methods rather than a current survey of the extensive literature in this field Two introductory chapters describe the basic theoretical aspects of vibrational spectroscopy on surfaces dealing with normal modes and excitation mechanisms in vibrational spectroscopy The remaining seven chapters deal with various methods employed to observe surface vibrations These are arranged in an order that first treats the use of various methods on surfaces that are not of the single crystal type It is in this area that the field first got started in the late 1940s with pioneering work by Terenin and others in the Soviet Union and by Eisehens and others in the United States in the 1950s The last four chapters deal with relatively recent methods that permit vibrational studies to be made on single crystal substrates **Surface Analysis Methods in Materials Science** D.J. O'Connor, Brett A.

Sexton, Roger S.C. Smart, 2013-06-29 The success of the first edition of this broad appeal book prompted the preparation of an updated and expanded second edition The field of surface analysis is constantly changing as it answers the need to provide more specific and more detailed information about surface composition and structure in advanced materials science applications The content of the second edition meets that need by including new techniques and expanded applications Newcastle John O Connor Clayton Brett Sexton Adelaide Roger Smart January 2003 Preface to the First Edition The idea for this book stemmed from a remark by Philip Jennings of Murdoch University in a discussion session following a regular meeting of the Australian Surface Science group He observed that a text on surface analysis and applications to materials suitable for final year undergraduate and postgraduate science students was not currently available Furthermore the members of the Australian Surface Science group had the research experience and range of coverage of surface analytical techniques and applications to provide a text for this purpose A list of techniques and applications to be included was agreed at that meeting The intended readership of the book has been broadened since the early discussions particularly to encompass industrial users but there has been no significant alteration in content *NBS Special Publication* ,1968

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Low Energy Electron Spectrometry Introduction

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