hossam maghraby

شبكة المعلومات الجامعية

بسم اللّه الرحمن الرحيم

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شبكة المعلومات الجامعية
التوثيق الالكتروني والميكروفيلم

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شبكة المعلومات الجامعية

جامعة عين شمس

التوثيق الإلكتروني والميكروفيلم

قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها علي هذه الأقراص المدمجة قد أعدت دون أية تغيرات

يجب أن

تحفظ هذه الأقراص المدمجة بعيدا عن الغبار

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شبكة المعلومات الجامعية

بعض الوثائق الأصلية تالفة

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بالرسالة صفحات لم ترد بالأصل

Utilization of Beams of Charged Particles in Scientific Research and Industry

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ABSTRACT

A detailed discussion has been described about theory to cover different aspects of Auger spectroscopy . physical principles of Auger process , secondary electron spectrum and its application to surface studies .

A beam of low energy electrons of 3000 eV is used to hit a coper target (coated with a thin layer of Nickel) at a glancing angle θ in order to produce Auger electrons . The primary beam (400 μA of about 4 mm diameter) bombarded the surface under investigation . The energy distribution of the secondary electrons was obtained by means of a four concentric semi-spherical grid arrangement and a collector . This arrangement used as a retarding field analyser RFA, organizes Auger electrons according to there energies in a spectrum . The retarding voltage , applied to the second and third grids , prevents electrons having an energy less than that corresponding to the retarding voltage from passing the grid system . A small voltage applied to the collector increases the energy of the electrons striking it so that stable collection is possible through adequate bombardment . The collected current obtained is recorded versus the retarding voltage . An operator named " ZAST " is used to calculate the second derivative of the collected current. A computer program has been prepared to interpolate the experimental data , calculate the second derivative and

integrate the results in order to get the energy distribution of Auger spectral lines . The collected current is also differentiated by applying a small AC modulation voltage to the retarding grids and tuning the detector to the frequency of the modulation . Parameters affecting the design and operation of the RFA are studied in order to obtain convenient results for Auger spectra . The modulation amplitude K and modulation frequency F are optimized in order to produce an electronic differentiation of the Auger collected current and accentuates the Auger peaks in contrast to the background .

The study of the present technique shows that the retarding field analyser yields a great resolution for the energies of the secondary electrons . Also , The informations obtained on the Auger spectrum which consist of the energy of the peaks , their shapes , widths and their relative intensities is discussed in a manner to be used as a tool of investigation of solid surfaces . Thus one can conclude that analysis using the technique of Auger spectroscopy has a great value in scientific research and industrial applications.

Introduction

Various experimental techniques have been developed to examine solid surfaces . The general requirements for any surface analytical method are that it should be simple , non - destructive and of high sensitivity to the properties of the surface region rather than to bulk properties , in order to get a comprehensive picture of the surface . The importance of Auger electron spectroscopy (AES) lies in the fact that it nearly satisfies all the above conditions . In practice , the most convenient and least destructive probes are x-ray photons and electrons (Duke and Park , 1972).

In the years 1925-1926 , P. Auger irradiated inert gases contained in a Wilson Cloud-chamber with a beam of x-rays and observed paired electron tracks originating from some of the ionized atoms . In each of these pairs , one track represented the photo - electron and had a variable length depending on the energy of the incident ionizing radiation . The other track had a constant length and represented the radiationless reorganization of the atom now named after Auger . In 1927 , G.Wentzel gave the non-relativistic theory of the Auger effect , explaining it as an autoionization process resulting from the electrostatic interaction between two electrons in an atom which is already singly ionized in an inner shell .

Evidently , this was one of the earliest applications of the newly-discovered tools of quantum mechanics .

Since then , a great deal has happened in the area of physics broadly labelled as inner-shell ionization phenomena . In particular , there has been a remarkable revival of interest in the Auger effect and allied processes . To an extent , this is a part of the renewed growth of atomic physics . At the same time , it is also related to technical developments in other areas like nuclear and solid state physics . For example , the availability of solid-state detectors and high resolution electron spectrometers with high transmission , has undoubtedly helped the measurement of fluorescence and Auger fields . The usefulness of Auger spectra in the analysis of surface impurities has , in recent years , necessitated the study of environmental effects on these spectra . Auger transitions are also important to the understanding of nuclear internal conversion and orbital capture of electrons , ion-atom collisions , etc ....

Because of its bearing on these diverse branches of pure and applied physics , the theory of the Auger effect deserves some attention at this point of time .

For identifying the chemical species occurring in the surface region , the simplest approach in principle would be to directly measure the ionization energy i.e. the energy required to create a hole in the core electronic state . In practice , it may be easier to measure another quantity , namely the energy of the electronic transition involved in the subsequent recombination of this hole with a valence electron . Such recombination can take place either via radiation transitions or through the emission of an Auger electron .

A core electron may be knocked out from a surface layer by an x-ray photon . This process is called Electron Spectroscopy for Chemical Analysis (ESCA) (Siegbahn et al. 1967a). In this method an x-ray beam of discrete energy E_x is directed onto a solid specimen and photo-electrons emitted by the surface are collected and their energy E_e analyzed . The difference between E_x and E_e is the work function W of the surface element ,

$$W = E_x - E_e$$

Ionization by x-ray or electron impact followed by the non radiative emission of an electron , is the technique called Auger electron spectroscopy (AES) . AES is based on the fact that each element has a well defined characteristic Auger line (well defined with regard to both energies and relative intensities) , which can serve as a kind of chemical signature for the element . The lines arising from solid state layers exhibit some energy broadening due to environmental effects and appear as low peaks against a general inelastic background . If we consider a particular Auger peak associated with an element present in a solid as the electrons generated within the solid travel towards the surface , they will lose energy to excitations of the valence electron fluid or plasma and undergo inelastic collisions with other electrons . Therefore only the Auger electrons coming from the few outermost layers of the solid will be detected as a part of the Auger peak in question. Auger electrons generated below these layers will lose enough energy to be scattered out of the peak into the elastic background and will not be detected as Auger electrons . The mean escape depth of Auger electrons may extend from two to four atomic layers (4-8 A°) (Palmbers and Rhoden 1968). Thus the Auger electrons actually detected come mainly from the surface region .

The usefulness of Auger spectra in the analysis of surface impurities has in recent years necessitated the study of environmental effects on these spectra . In that domain Auger transitions are also important to the understanding of orbital capture of electrons , ions , atom collisions ....

However , ionization caused by electrons do have an edge over that caused by x-rays because of the following reasons :

1- Electron penetration in solids :

Penetration of the primary beam into the solid is limited basically by inelastic events . Electrons interact more closely with matter and have a vasty smaller penetrating power than x-rays . For example an aluminum sheet of 3 cm. thick absorbs only 90 % of the beam intensity of hard x-rays ($\lambda = 0.2$ A°) while 5 μ of the same material can halt 100 KeV. electrons completely . Hence ,the use of low-energy electron beam ensures that only few surface layers are sampled .

2- Monochromatism :

By using suitable electron optics it is easier to obtain a monochromatic electron beam than with x-rays . The latter generally consist of lines superimposed on an intense continuous background . To monochromatize such a beam , we must use either filters or selective reflection at a crystal with a marked reduction in beam intensity .

3- Power and intensity :

Fine and intense electron beams are easily obtained whereas this is quite difficult for x-ray owing to the generally low efficiency of x-ray tube ($\approx$ 1/1000) and