Middle-East Journal of Scientific Research 8 (4): 769-772, 2011
ISSN 1990-9233

The Practical Difficulties in Detecting Spectra of Ultra Thin Layer

[1]A. Sadeghi, [2]A. Bahari and [3]Abdol Ghaffar Ebadi

[1]Department of Chemistry, Jouybar Branch, Islamic Azad University, Jouybar, Iran
[2]Department of Physics, University of Mazandaran, Babolsar, Iran
[3]Department of Biology, Jouybar Branch, Islamic Azad University, Jouybar, Iran

Abstract: The conventional electronic, optoelectronic, chemical instruments and devices technology reach their scaling limit. Many researchers have approached novel concepts, such as nanotube, nano fibber and Bio-based nano-electronic, as alternatives. They are normally molecular-scale wires with atomically well-defined structures. Since low-dimensional nanomaterials have received considerable attention in recent years, their widely potential applications in electronic and optoelectronic devices are become so important in any investment and progress. To study these nano scale materials and films, some techniques like AES (Auger Electron Spectroscopy), XPS (X -ray Photoemission Spectroscopy), AFM (Atomic Force Microscopy) and so on have been used, because they lend themselves very well for measuring and imaging ultra thin films. However, the growth and synthesis the ultra thin film and studying their nano-structural properties, are facing some difficulties due to Faraday cup and leakage current. In the present work, we have taken into account the Faraday Effect in ultra-thin films and nanostructures for the approximate upper limits of enhancement and the associated photometric parameters of the system.

Key words: Nanodevices · Ultra thin film · XPS · AES techniques · Faraday effect

INTRODUCTION

The surface techniques used can be divided into three categories depending on their relevance for the analysis: Direct imaging techniques including scanning probe imaging, diffraction techniques and spectroscopical techniques. Although this classification is not unique, it gives a rough guideline for the discussion. The direct imaging techniques probe a real space visualization of some physical property in a microscopic section of the surface. Most of the direct imaging techniques have an excellent spatial resolution and seem fairly easy to interpret, although some problems may complicate a straight forward interpretation. Direct imaging is done by techniques such as Scanning Tunnelling Microscopy (STM), Scanning Electron Microscopy (SEM) and scanning Auger microscopy (SAM). Diffraction techniques such as Low Energy Electron Diffraction (LEED) are useful for obtaining information on the geometry and spatial ordering of atoms of ordered surfaces. Last, the spectroscopical surface techniques such as Synchrotron radiation for High Resolution Photoemission Spectroscopy (HRPS), X- ray Photoelectron Spectroscopy (XPS) and Auger Electron Spectroscopy (AES) form a very broad class [1-5].

In these techniques, some kinds of energy distribution of particles emitted from the surface have been measured. It may be distributed over energies, angles, temperatures or other parameters and the particles may be incident particles that has been backscattered, or particles that has been ejected due to excitations in the surface region [6-9].

AES, XPS and HRPS are rightly considered routine tools for surface science and for many applications in the development of advanced materials, devices and processes due to their high surface sensitivity, their capabilities of qualitative (both in terms of atoms and of their chemical situation) and quantitative analysis. They can be applied to real world samples as well as to model systems and their relatively low destructive action on surface systems. In this work we will mainly be concerned with detecting difficulties aspects of XPS/AES and HRPS measurements.

Experimental Data and Discussions: Clean silicon surfaces are highly reactive and even a minute presence of other species such as oxygen on the surface results in significantly altered electronic properties. Thus, it is crucial to have a clean crystal (surface).

Corresponding Author: Mr. A. Sadeghi, Department of Chemistry, Jouybar branch, Islamic Azad University, Jouybar, Iran.

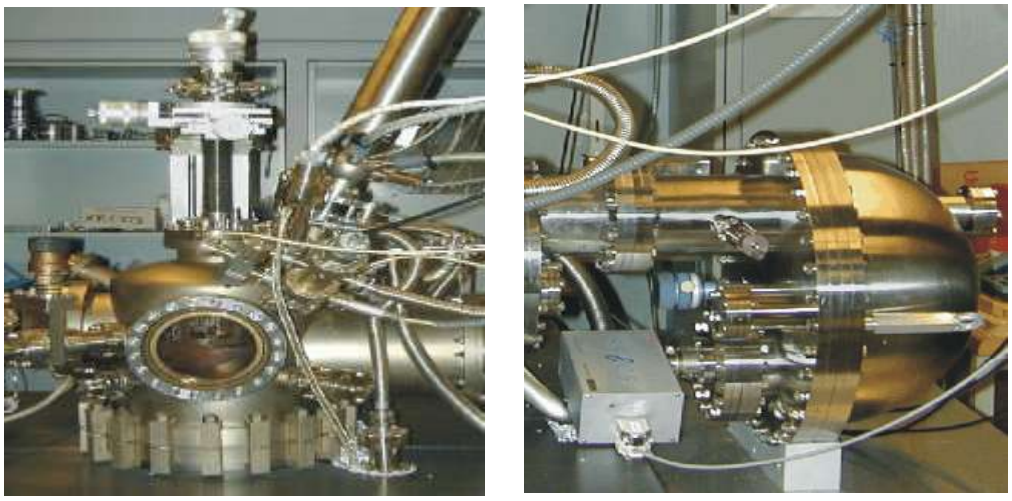

Fig. 1: (up) the main chamber (down) analyser chamber of XPS and AES which we have used before for growing ultra thin film on silicon substrate.

Because, if the specimen analysed is not representative of the desired surface, the outcome can be worse than doing no analysis at all.

Thus, in order to perform controlled experimental studies on surface, the pressure must be sufficiently low to prevent appreciable surface contamination in the time span of the measurement. If the vacuum system cannot attain base pressures below 5 x 10^{-9} Torr, most surfaces cannot be kept sufficiently clean for detailed analysis. To illustrate this point, consider a solid surface with a sticking coefficient for gas adsorption of 1. The solid surface will be covered with one monolayer (1 Ml) of contaminant in 1 sec at 10^{-6} Torr and thus significantly lower pressures of the order of 10^{-10} - 10^{-11} Torr are needed for practical experiments [10]. These issues need access to several kinds of pump systems. Most manufactures of current AES and XPS instruments use similar pumping systems. The analysis chamber is most commonly pumped with an ion pump and is isolated from the specimen insertion chamber with a gate valve. Some systems have a preparation and/or treatment chamber that is coupled with the specimen insertion system (Figure 1).

For cleaning and repairing the XPS and AES equipments, the main and analysis chambers (Figure 1) should be opened to atmospheric pressure. It may afterwards be pre- evacuated through the specimen insertion system.

In XPS spectra, AES emission will also occur as shown in Figure 2. One way to tell AES peaks from XPS peaks is by changing the exciting radiation energy, since kinetic energies of Auger electrons are independent of photon energy, while kinetic energies of photoelectrons depend on photon energies.

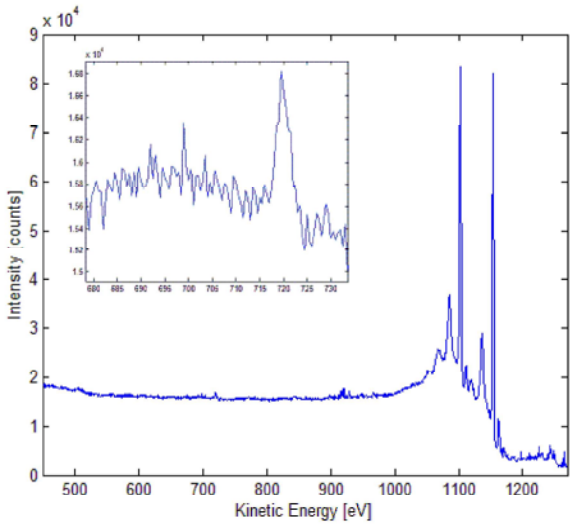

Fig. 2: The Auger peak is shown in inserted figure. Both XPS and AES spectra can be seen in this figure for silicon dioxide on the silicon substrate. Hugh peaks are due to silicon and small peak at 720 is due to oxygen.

Moreover, these techniques are worked with some magnetic media between to Bragg reflectors (optical quarter wave mirror systems) as a means of stimulating large magneto-optical effects. As shown in figures 3 and 4, the localized modes of optical waves give reduce to resolution enhancements. In addition, incoming particles like electrons and x- rays on the sample surface because stacking defects, interrupting the periodicity of the structure, enhances the localization of light within the photonic crystal, which may be influenced with magneto-optical effects.

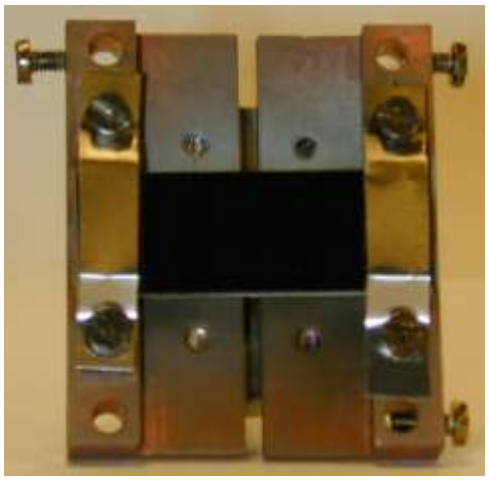

Fig. 3: Sample holder built with Ta and used for cleaning silicon sample inside the ultra high vacuum chamber.

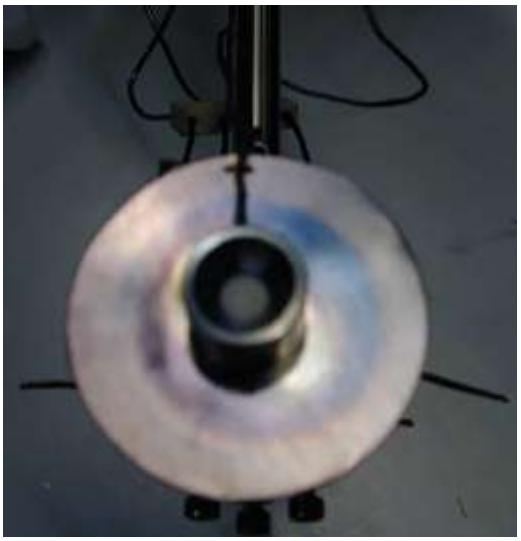

Fig. 4: It reveals some problems around the sample holder after passing current through the sample.

Furthermore, the main problem in detecting procedures is calibration point which can describe the phenomenon and the references to a magnetophotonic crystal or Fabry-Perot optical filter. It is well known to possess an optical resonant cavity where electromagnetic fields can be very large depending on: (1) the reflectivity of the mirrors, (2) the thickness and (3) absorption of the cavity layer.

However, the Faraday effect can be occurred for the fundamental limits of enhancement in terms of intrinsic material parameters using the concept of the Fabry-Perot etalon and their validity is confirmed and their meaning illustrated (see figure 5 as an example).

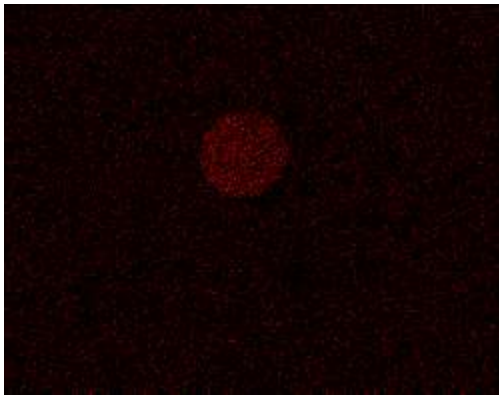

Fig. 5: There are some unwanted scattered atoms on the sample surface with using SEM technique.

It leads to the kinetics of the reactions between incoming atoms, x-rays and sample surfaces which can cause the formation of interface between films and substrate. Forming of the ultra thin film, the atoms like oxygen and/ or nitrogen must be deposited on the surface of the samples, in where removing any dirty and impurity is so complicated problem. Because for cleaning the sample surface or removing the native oxide on top of silicon substrate, which is so important in growing so thin film, we need sputtering procedure with argon ions. The main requirements for a monolayer of film can affect on sufficient thickness and porosity, homogeneity and mechanical stability and the absence of cracks and exfoliation from the carrier. Analysis of the above mentioned stages must be optimized for obtaining ultrathin layer film on top of the substrate. Otherwise, the native film on top of substrate sample prevents ultrathin film, less than 1 nm that is necessary for nano electronics and optoelectronics devices [11].

On the other hand, in SEM images, the effect of backscattering is to decrease the X-ray intensity with increasing Z, which is opposite to the effect of stopping power. The higher the primary-electron energy, the more inelastic collisions it takes to slow them to rest and greater the penetration depth and lateral spreading. As a result, the X-ray intensity per unit concentration increases with Z. Therefore, if the mean atomic number of the standard differs from the sample, it must be accounted for in the matrix correction. An area of a sample that has a high atomic number (Z) will have backscattering events occurring with a higher frequency than surrounding areas with a lower atomic number. This is due to the difference in the sizes of the respective nuclei. The spectral resolution, the ability to resolve one peak from another, is thus dependent of the atomic number of the element [10-15].

CONCLUSIONS

By looking at sample holder, which is built by Ta at figures 2, it is clear some, unwanted oxidize materials and carbon atoms are built in on the sample surface, here, on the silicon substrate. Although the base pressure inside the ultra high vacuum chamber is 10^{-7} Torr, during oxygen and/ or nitrogen exposure, these problems can cause some impurities and even barriers on the sample surface to prevent the pure and without dirties film on the sample surface as needed for nowadays device generations.

The fundamental parameters of the effect, such as the relative contributions of interface and bulk spin dependent scattering are difficult to obtain using the rastered area. Measuring with the current perpendicular to the Farady cup and focusing inside the centre of cup solves most of these problems, mainly because the electrons cross all magnetic layers, but a practical difficulty is encountered. The reason is that the perpendicular resistance of the ultra thin multi-layers is too small to be measured by ordinary techniques. All of above examples and points indicate some practical problems in detecting the nano scale materials.

ACKNOWLEDGEMENT

This paper extracted form a university project titled "The practical difficulties in detecting spectra of ultra thin layer" and funded by Jouybar branch, Islamic Azad University of Iran.

REFERENCES

1. Sikka, S.K., Y.K. Vohara and R. Chidambaram, 1982. Omega phase in materials. Progress in Materials Sci., 27: 245-310.
2. Lee, J.D., H.C. Kim, Y.S. Kim, Y.D. Kim and M.S. Lee, 2007, Solid State Phenom. 124-126: 1059-1062.
3. Iwamoto, S., W. Tanakulrungsank, M. Inoue, K. Kagawa and P. Praserthdam, 2001. Synthesis of large-surface area silica-modified titania ultrafine particles by the glycothermal method, J. Mat. Sci. Lett., 19: 1439-1443.
4. Bahari, A., P. Morgen and Z.S. Li, 2006. Valence Bend Studies of the Formation Ultra thin Pure Silicon Nitride Films on Si(100). Surf. Sci., 600: 2966-2971.
5. Morgen, P., A. Bahari, K. Pedersen and Z. Li, 2007. Plasma assisted growth of ultrathin nitrides on Si surfaces under ultrahigh vacuum conditions. J. Phys., 86: 12019-12038.
6. Bahari, A., P. Morgen and Z.S. Li, 2008. Ultra thin silicon nitride films on Si(100) studied with core level photoemission. Surf. Sci., 602: 2315-2324.
7. Kim, S.J., S.D. Park, Y.H. Jeong and S. Park, 1999. Homogeneous precipitationof TiO2 ultrafine powders from aqueous TiOCl2 solution, J. Am. Ceram. Soc., 82: 927-932.
8. Ding, Z. X.J. Hu, G.Q. Lu, P.L. Yue and P.F. Greenfield, 2000. Novel silica gelsupported TiO2 photocatalyst synthesized by CVD method, Langmuir, 16: 6216-6222.
9. Kato, K., A. Tsuzuki, H. Taoda, Y. Torii, T. Kato and Y. Butsugan, 1994. Crystal Structures of TiO2 Thin Coatings Prepared from the Alkoxide Solution via the Dip-Coating Technique Affecting the Photocatalytic Decomposition of Aqueous Acetic Acid, J. Mater. Sci., 29: 5911-15.
10. Abe, Y., N. Sugimoto, Y. Nagao and T. Misono, 1988. Preparation of Monolithic SiO2-TiO2 Gels by Condensation Polymerization of Silicic Acid and Titanium Chelates, J. Non-Cryst. Solids, 104: 164-69.
11. Yongxiang, Z., X. Linping, W. Yongzhao, G. Chunguang and L. Diansheng, 2004, Preparation of Ti-Si mixed oxides by sol-gel one step hydrolysis, Catal. Today, 93-95, 583-588.
12. Bahari, A., M. Riazian and R. Ahmadnejad Ultra Thin Dielectrics for CMOS-Elements. World Appl. Sci. J., 7(10): 1252-1254.
13. Bahari, A., 2008. The Effect of the Fractal clusters on the Si (111)- 7×7 Surface, World Appl. Sci. J., 4: 261-265.
14. Roodbari, M., M. Rezaee and N. Shah Tahmasbi, 2009. Structural Properties of Ultrathin Al_2O_3 Films on Si. World Appl. Sci. J., 7(Supplement 1): 12-14.
15. Bahari, A., F. Ashrafi, S.A. Babanezhad and M. Khalili, 2009. Surface Chemistry of Nano Austenitic Stainless Steel. World Appl. Sci. J., 7(Supplement 1): 33-35.