Factors Effecting Work Functions And Causes Time Delay To Kick Electron From Material When Photon Incident On Electron.

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ABSTRACT

The objectives of this research work is to study the both minute and major factor which play an important role to increase or decrease the work functions of an atom, and effect of these factor on time delay to kick out the electron. The factors may be pressure exerted on atom either pulling or pushing of an atom from external environment, electron-electron, electron-proton, electron-neutron, proton-neutron-electron attraction or repulsion inside the atom, consider atom and surrounding environment like effect of free charge particle, atom, neutral charge and other. These all are the factor which are responsible for work functions of any atoms and time delay to kick out the electron from surface of material. Some of them play minute role while some of them play major role for work functions. The time delay of kick out the electron from surface depend of on the energy of incidence photon on target electron. This delay occur in between valance and conductance band of consider atom or material.

Keywords : ***Effect of Pressure, Electron-Electron, Electron-Proton, Electron-Neutron, Proton-Neutron-Electron Attraction or Repulsion, Delay Time etc***.

1 INTRODUCTION

The attention on the nature of work function was study my number of physics and scientist such as Einstein, Richardson, Jentzsch, Debye, Schottky and Langmuir at the beging of 20th which is already introduce by Thomson for macroscopic bodies. However, at the end of 20th century the idea of the image potential as the main contribution to WF was restored by Brodie and subsequently improved by Halas and Durakiewicz. The last approach has appeared to be very useful in calculation of WF of conducting compounds and ionization potentials of metallic clusters. Schottky in 1923 assumed that without external field an electron outside of a metal surface experiences the electrostatic image force and considering the potential energy of an electron at distance x, we have $W= -e^2/(16\pi\epsilon_0 x)$ [1].

The work function ϕ as the minimum extra energy, measured above the Fermi level E_F, which an electron must obtain in order for it to escape from the solid. It is equal to the difference in energy between the Fermi level and the energy of an electron outside the material and Rough surfaces have smaller work function is called Smoluchowsky effect [2]. The work function increases linear with the free electron density and equals the exchange energy given by the Hartree-Fock model of electrons. Electron-Electron interaction is the major factor that contributes to the observed work function of metals. The photoelectric effect is the result of a phase transition in an electron gas that connects a condensed surface state to a free continuum state. The assignment of a phase transition to the effect under consideration is justified by analysing the behaviour of the Fermi-Dirac energy distribution upon raising the Fermi level. The electron-electron interaction gives rise to the so-called exchange energy term that is given as a function in the electron density ($1/r_s$) by $E_{exchange}=-0.456e^2/(4\pi\epsilon_0 r_s)$. This term represents the average binding energy of a single electron to the ensemble as a result of exchange interaction [3].

Incident primary electrons are accelerated by the surface potential barrier to the value $E_s = E_k + E_F + e\varphi = E_k + eV_i$ and then they penetrate the solid target as deep as 50 – 100 Å. Electrons lose their energy in that act, produce secondary electrons, and are also elastically scattered by atoms of the solid. This scattering can be described by Legendre polynomials. At $E_k < 10$ eV the wavelength λ of the electron is much greater than the inter atomic distance $r_{eff.}$ $\lambda/2\pi = h/2\pi p >> r_{eff}$. where p is an electron momentum. If an electron has small kinetic energy E_k in vacuum, this electron cannot overcome the potential barrier [4]. The work function trends of a series of perovskite (ABO_3 formula) materials using Density Functional Theory, and show that the work functions of terminated AO- and BO_2-oriented surfaces can be described using concepts of electronic band filling, bond hybridization, and surface dipoles. The calculated range of AO (BO_2) work functions are 1.60-3.57 eV (2.99-6.87 eV). HSE functional of Heyd, Scuseria and Ernzerhof within Density Functional Theory (DFT) with Hartree-Fock exchange fractions. The work function using concepts of bonding ionicity, hybridization, band filling, and surface dipoles [5].

The image-force expression for the energy required to remove an electron from an isolated finite metal particle, modelled as a conducting sphere of radius R. The work required to move the electron from a distance d outside the metal surface to infinity against its image charge is given by $\phi(R) = = e^2/4d[1 + 4(d/R) + 6(d/R)^2 + 2(d/R)^3]/[(1 + d/2R)(1 + d/R)^2]$. The first factor on the right-hand side represents the bulk (R tends to infinit) work function: $W = e^2/(4d)$ [6]. The polycrystalline surface may be treated as a composition of patches each patch being a $\phi_p = \sum_i f_i \phi_i / \sum_i f_i$ of crystals and the φ_p may be interpreted as an average of the work function of all exposed patches is , where φ_p is the work function of cleavage corresponding to the i-th patch, and f_i is its weight simple.The face-dependent work function may be represented by a sum, $\varphi_i = \varphi_{fl} + \delta\varphi_i$ where φ_{fl} is the face-independent part of work function and $\delta\varphi^i$ is face-dependent part of work function [7].

The potential well whose depth Δv_{eff} is the sum of the cohesive force potential $|V_{xc}(\rho^+)|$ and the electrostatic force potential $\Delta\varphi$. The work function is defined as $\varphi = \Delta v_{eff} - (\hbar^2/m)k^2_F$. The origin of the electrostatic force is the spill-out of electrons in the solid to vacuum. The theory of work functions based on first principles utilizing the density functional theory (DFT) was initiated by Lang and Kohn assuming a jellium surface, where electrons and ion cores are uniformly distributed. Stricter work function calculations were made by applying self-consistently the linear muffin-tin orbital method to include exact optimum positions of ion cores [8].

2 REVIEW

In the free electron model, valence electrons can be treated as free, or at least moving in a region constant potential, and non-interacting. From atomic theory, we are used to the idea that different electronic functions must be orthogonal to each other i.e. $\int\psi_c(r)\psi_v(r)dr = 0$. For a typical solid, the interatomic spacing is about 2.5×10^{-10} m. If two metals with different Fermi energies are brought into contact, electrons will move so as to equalize the Fermi levels [9]. The photon is absorbed if its quantum of energy exceeds the binding energy of an electron in the discrete bound state of the absorber. The excess energy is then carried as kinetic energy of the escaping 'photo-electron'. The binding energy of the photoelectron is then associated with the difference between the energies of the N-electron system, and an (N-1) electron system with a vacancy in the state from which photo-electron is considered to be ejected with very simple equation known as the Koopmans theorem, $E_{HF}(N\text{-}1,i) - E_{HF}(N) = -\varepsilon_{HF,i}$. The Koopmans theorem establishes a direct link between experimentally measurable electron binding energy and the result of the Hartree-Fock mathematical solutions [10].

If all of this electrical power is converted into light and deposited as a wave uniformly over the photocathode, then each electron receives a fraction of power given by, $p_c = P_{LED}(A_c/A_{pc})$, where P_{LED} is the LED electrical power, A_e the area occupied by an electron, and A_{pc} the area of light on the photocathode. In a solid, atoms are typically 0.3 nm from each other, so each electron is confined to an area of $9\text{x}10^{-20}$ m^2. The photo-cathode has a work function of 1.4 eV, so it should take at least 12 ms for an electron to absorb enough energy to escape the photo-cathode [11].

The pions are said to be continuously consumed and released by proton-neutron exchange processes and related with shielding or screening effect. The electrons residing in the innermost shell experience the attraction of full charge of the nucleus but this is not true for the electrons contained in the outer shells. The shielding effect caused by inner electrons varies with the type of sub-shells to which these electrons belong, e.g. s > p > d > f. This shows that s-electrons cause maximum shielding effect followed by p, d and f-electrons [12]. The surface roughness and the work function increased with deformation in the elastic region and reached the maximum values at the yield point. In the plastic deformation stage, the surface roughness continued to increase, while the work function decreased and stabilized. The surface roughness is the major factor affecting the work function during elastic deformation, while dislocations and slip bands play the key role during plastic deformation [13].

On the basis of Brodie's definition of the work function and the length of spontaneous polarization of plasma and derived: $\phi/\text{eV} = 43.46\alpha r^{-3/2}_s (E_F/\text{eV})^{-1/2}$, where r_s is the electron density parameter expressed in units of the Bohr radius, E_F is the Fermi energy and α is an empirical constant. In the case of a planar conducting surface kept at zero potential, the work required to remove an electron initially at a distance d_0 to infinity is $W_{image} = e^2/(16\pi\varepsilon_0 d_0)$, where e is the elementary charge and ε_0 is the permittivity of vacuum. The reduction of the work-function value that occurs when an external homogeneous electric field is acting between a planar metal surface and a remote anode. The polarization requires energy, which in the case of gaseous plasma is derived from the thermal energy [14].

It is the strong nuclear force, acting between both protons and neutrons, which holds the nucleons together inside the nucleus. In all multi-electron atoms, internal electrons have radius smaller than hydrogen by a factor Z , and their binding energy is larger by a factor close to Z^2. An electron in an internal orbit is strongly bounded, because it strongly feels the attraction of the nucleus, and at the same time the repulsion from the other electrons cancel in the average. When the electron is in an external orbit, the net effects of the repulsion add coherently, effectively screening the nuclear charge and net potential seen by the electron is defined as $V=-Z(r)\, e^2/r$ [15]. The Yukawa potential is an effective non-relativistic potential describing the strong interactions between nucleons. It takes the form $V(r) = -\alpha e^{-\mu r}/r$, and thus can be seen as a screened version of the Coulomb potential, with α describing the strength of the interaction and $1/\mu$ its range. The same potential appears under the name of the Debye–Hückel potential in plasma physics [16].

The interaction calculation (CI) Hamiltonian for M valence electrons is calculated using orbitals in complete V^N potential $\hat{\Sigma}_1 + \hat{\Sigma}_2$ are added to the CI Hamiltonian to account for the core-valence correlations. If the core electrons and valence electrons belong to different shells the effect on V_{core} can be extremely small. Indeed, in this case the overlap between density of the valence electrons and density of the core electrons is small. If the electrostatic potential V_0 created by valence electrons is nearly constant inside the core then the V^{N-M} approximation is equivalent to the $V^{N-M} + V_0$ approximation, where V_0 can have contributions from all M valence electrons, or any fraction on them or it can be just a model potential [17].

Debye screening to the electron-electron interaction in the form of, $V_{ij}=-(e^2 x e^{-rij/D})/r_{ij}$, where r_{ij} is the distance between the atomic electrons and D is smaller than the average size of an isolated atom in that particular bound state. The N-electron Hamiltonian for an atom in plasma environment in our photo-ionization calculation is expressed as, $H(r_i, r_j, \ldots\ldots\ldots;D)=\Sigma_{i=1,N} h_0(r_i\, ;\, D) + \Sigma_{i>j}^{N}\, e^2/r_{ij}$, where $r_{ij} =| r_i - r_j|$ represents the separation between the atomic electrons i and j [18]. Yukawa noticed the potential of force between the neutron and the proton should not be of Coulomb type, but decreasing much more rapidly with distance. Assuming $\lambda = 5\times10^{12}\ cm^{-1}$, he obtained for the mass of the new quantum a value 2×10^2 times as large as the electron mass and notes that the potential V is a static centrally symmetric solution of the wave equation [19].

In plasma physics, the potential is known as the Debye– Hückel potential which describes the ion potential shielded by the presence of neighbouring charged particles for ideal and weakly non ideal plasmas, and $\mu = 1/r_D$ is the reciprocal of the Debye length r_D. In atomic and molecular physics, μ is the screening parameter and its reciprocal $1/\mu$ describes the effective screening range of the potential. The Yukawa potential is a potential induced by a massive intermediate scalar particle with mass μ. If $\mu = 0$, the exchange particle becomes massless and the short-range interaction becomes the long-range Coulomb potential. When $\mu' < 0.8942$, the critical value of α for the spinless Salpeter equation becomes larger than that for the Schrödinger equation. As $\mu' > 0.8942$, the critical value of α for the spinless Salpeter equation becomes smaller than that for the Schrödinger equation [20].

When a particle is in a strong interaction (range of interaction exceeds the screening length, $\lambda = \alpha^{-1}$), the relativistic effect must be considered which gives the correction for non-relativistic quantum mechanics. Dirac equation the spin symmetry arises if the magnitude of the spherical attractive scalar potential S(r) and repulsive vector potential are nearly equal i.e., $S(r) \sim V(r)$) in the nuclei i.e., when the difference potential $\Delta(r) = V(r) - S(r) = Cs$, with Cs is an arbitrary constant. In the presence of spin symmetry, the appropriate value for Cs falls in the range $-20\ fm^{-1} \leq Cs \leq 8.8\ fm^{-1}$ for positive energy part while $0\ fm^{-1} < Cs \leq 9.6\ fm^{-1}$ for the negative energy part. The resulting solutions of the wave functions are being expressed in terms of the Jacobi polynomials [21].

The van der Waals potential is simply the shift in the ground state, zero point, energy due to the Coulomb interaction and is found to be features in physics and is familiar to any student of the subject. Van der Waals force can be understood from a simple one-dimensional model of the atom which consists of electrons bound by harmonic oscillator forces to heavy protons at fixed separation R in addition to Coulomb interactions between the four charges is found to be

$$V(R) = \frac{-e^4}{32\pi^2 m^2 \omega_0^3 R^6},$$

where R is the sepration of atom w_0 is the oscillration of bounded electron due to protron and m is mass of oscillation electron on an atom. Since, Van der Waals force is due to the self-interaction of the dipole moment of an atom with the electric field generated by the correlated dipole moment of an atom at distance R [22].

Van der Waals attraction, it is tacitly assumed that we are dealing with molecules-atoms. F. London using perturbation theory showed that even if neither molecule possessed a permanent dipole moment, they still would attract each other. It was only necessary that dipole moments could be induced in both molecules. Non retarded forces are then good approximations when the distance between the molecules is small. London's work refers to non-retarded dispersion forces and shows that for two identical polarizable atoms the interaction potential energy is given by

$$U(r) = -\left(\frac{1}{4\pi\epsilon}\right)^2 \frac{3h\omega_0 \alpha^2}{4\pi r^6}$$

Basically, retardation effects change the $1/r^6$ behavior of the interaction energy to $1/r^7$ [23]. The interaction force gradient between a micron-size polystyrene sphere and an atomically flat highly oriented pyrolytic graphite substrate has been analyzed as a function of surface-to-surface separation distance z_0 using an oscillating cantilever technique. The interaction force gradient was found to have two contributions. For $z_0>30$ nm, an electrostatic force due to charges trapped on the polystyrene sphere dominates. For $z_0<30$ nm, a van der Waals interaction, characteristic of a sphere near a flat plane, is observed [24].

Van der Waals force and Casimir force can both be connected with the existence of zero-point vacuum oscillations of the electromagnetic field. It is found that the Casimir force is generally effective at larger separation distances between the bodies than the van der Waals force. Whereas the Casimir force between semi-infinite parallel plates is inversely proportional to the fourth power of the gap, van der Waals force is inversely proportional to the third power of the gap. Nano-Scale surface forces are described using the Van der Waals force [25]. Let us now consider a point-charge particle of charge z. For such a particle, we may write the charge density and the current density $\rho(r) = z\delta(r)$ and $J(r) = zv\delta(r)$ respectively. Where, r is the position of the observer relative to the particle, whereas v the velocity of the particle relative to the observer. Now particle is moving at constant velocity so, that its position at a given time may be written as $r(t) = r_0 - vt + O(v^2/c^2)$. Where r_0 is the position at time t = 0 and where the term proportional to v^2/c^2 has been included from relativistic considerations. The potentials generated by such a particle is $\varphi(r) = (z/4\pi\varepsilon_0 r) + O(v^4/c^4)$ and $A(r) = (z/8\pi\varepsilon_0 c^2 r^3)\,[r^2 v + (v \cdot r)\, r] + O(v^3/c^4)$. It should be emphasized that the expansions of the scalar and vector potentials [26].
High energy scattering experiments limit the size of the electron to less that 10−16 cm, which rules out models of the electron as an extended body. After a lengthy analysis of the Dirac equation Bohm and Hiley conclude: Electron must still be regarded as a simple point particle whose only intrinsic property is its position. Under this assumption, spin and phase must be expressed in the kinematics of electron motion [27]. In analyzing free-particle wave packet solutions of the Dirac equation, Schroedinger noted the existence of interference between positive and negative energy states oscillating with circular frequency, $\omega_0 = 2mc^2/\hbar = 1.6 \times 10^{21} s^{-1}$ and interpreted this as a fluctuation in the position of the electron with radius, $\lambda_0 = c/\omega_0 = \hbar/2mc = 1.9 \times 10^{-13}$m. Interpreting the oscillation between positive and negative energy states

3 METHODOLOGY

This is theoretical approximation to calculate the work function or amount of energy to eject an electron from an atom in solid. Some of major Factor or parameter that play an important role to increase or decrease the work function of an atom of a material with certain condition i.e. in absence of electric field, at normal STP (Standard, Temperature and Pressure), exposed of material in natural air composition (may be surrounded by certain free charge particle and massive ions particles which may generate the field).

Major Factors are listed below which effect on the work function and time delay:

1. **Attraction between nucleus of an atom and target electron of same atom:** Attraction between nucleus of an atom and target electron which is going to be kick out from the atom of a material is one of the factor effecting. Let us consider an material is made up of same type of atom (poly mono atom). Consider charge of an nucleus of an atom having charge is Q and charge of an electron on the orbit of an atom is $-q_T$ which is going to be kick out from the material by using a energy of photon hf, separated by a distance r_i. Then the potential energy between Q and $-q_T$ located at a certain distance r_i is given by

$$U_{PEQ}(-q_T) = -K\sum_{i=1}^{N} Q\frac{q_T}{r_i}\text{..}(1)$$

Here $U_{PEQ}(-q_T)$ is the potential energy generated for $-q_T$. And sum from i=1 to N means the variation of the position of electron around the nucleus in a same orbit. The value of $K = \frac{1}{4\pi\epsilon_0}$ is coulombs constant.

2. **Conversion of proton into neutron and Neutron inside the nucleus:** During the conversion of neutron into proton and vice-versa the effect of the charge during this process is also have effect on the electron which is revolving around the nucleus of an atom. The Yukawa potential an effective non relativistic potential describing the strong interactions between nucleons. It takes the form

$$U_{YP}(r) = -\alpha\frac{e^{-\mu r}}{r}\text{..................................}(2)$$

and thus can be seen as a screened version of the Coulomb potential, with α describing the strength of the interaction and 1/μ its range. This is short ranges potential but have an influence to the electron which is more closure to it and due to the influence of this potential in nearest electron the system of the atom electron arrangement is change and in this way the target electron which is going to be kick out is effected by Yukawa potential. Hence in this way, although Yukawa is short ranges strong force it effect on the work function of an electron or material.

3. **Attraction between nuclei of surrounding an atoms and target electron atom which is going to kick out from an atom of material:** Let us consider an atom whose electron are going to be kick out by the energy of photon hf is surrounding by number of atom i.e. electron is ejected from the surface of the material. Then the potential energy between nuclear charge of surrounding atom Q_{sj} and $-q_T$ is charge of target electron which is going to be kick out from an atom given by

$$U_{PEQsj}(-q_T) = -K\sum_{j=1}^{N} Q_{sj}\frac{q_T}{r_{jT}} \quad \ldots\ldots\ldots\ldots(3)$$

where r_{jT} is the distance between Q_{sj} charge and $-q_T$. $Q_{PEQsj}(-q_T)$ is potential energy that bound the $-q_T$ target electron which is kick out from an atom by photon energy hf.

4. **Repulsion between an electrons and target electron of same atom which is going to be kick out from an atom of material:** The repulsion of the electrons of an atom and target electron which is going to be kick out from the same atom is give by

$$U_{PEqk}(-q_T) = K\sum_{k=1}^{N} q_k\frac{q_T}{r_{kT}} \quad \ldots\ldots\ldots\ldots(4)$$

where r_{kT} is the distance between the electrons $-q_k$ and target electron $-q_T$ which is going to be kick out of same atom. $U_{PEqk}(-q_T)$ is energy by which electron are repel each other.

5. **Repulsion between an electron of surrounding atom and target electron which is going to be kick out from an atom of material:** The repulsion of the electrons of surrounding atom and target electron which is going to be kick out from the same atom is give by

$$U_{PEsm}(-q_T) = K\sum_{m=1}^{N} q_m\frac{q_T}{r_{mT}} \quad \ldots\ldots\ldots\ldots(5)$$

where r_{mT} is the distance between the electrons $-q_m$ and target electron $-q_T$ which is going to be kick out of same atom. $U_{PEsm}(-q_T)$ is energy by which electron are repel each other.

6. **Energy gap between conductance and valance band:** when electron are trying just leaving the valance band it have travel a certain distance to reach at conductance band from where it kick out from surface. Let the energy be E_{VC} required to travel a electron from valance band to conductance band.

7. **Van Der Waal Potential:** Let us consider a system containing number of similar atom and a target electron is kick out from atom which is on the surface of material:

8.

$$U_{VDWP}(-q_T) = -\sum_{n>1}^{N}\sum_{p=1}^{N'} q_T\frac{q^{n-1}}{32\pi^2 m^2\omega_0^3 R_{pq_T}^6} \quad \ldots\ldots\ldots\ldots(6)$$

n-1= number of an electron in consideration system which are responsible for van der val potential

R_{pqT} = distance separation of two bounded system I.e target electron bounded by a nucleus of its own system and surrounding bounded electron of consider atom up to which target electron is consider to effect by van der val potential. $U(R_{pqT})$ =Van Der Waal potential, q^{n-1} is electron surrounding by bounded system to q_T bounded system.

The above factors are responsible for the work function of the material and consumed the tiny segment photon of a single photon to kick out the electron from the surface of material. In such case the, the amount of energy of the single incident photon on the electron of an atom of a material is greater than the total energy of the electron bounded by its atom and surrounding atom. Hence the amount of energy required to kick out the electron from surface of atom should be equal to hf of greater than sum of the energy by which an atom and electron is bounded i.e.

$$U_T(r) = U_{PEQ}(-q_T) + U_{PEQsj}(-q_T) + U_{PEqk}(-q_T) + U_{PEsm}(-q_T) + U_{VDWP}(-q_T) + U_{YP}(-q_T) + E_{VC} \ldots\ldots\ldots(7)$$

$$U_T(r)=-K\sum_{i=1}^{N} Q\frac{q_T}{r_i}-K\sum_{j=1}^{N} Q_{sj}\frac{q_T}{r_{jT}}+K\sum_{k=1}^{N} q_k\frac{q_T}{r_{kT}}+K\sum_{m=1}^{N} q_m\frac{q_T}{r_{mT}}-\sum_{n>1}^{N}\sum_{p=1}^{N'} q_T\frac{q^{n-1}}{32\pi^2 m^2\omega_0^3 R_{pqT}^6}-\alpha\frac{e^{-\mu r}}{r}+E_{VC}\ldots\ldots(8)$$

$$U_T(r)=K\sum_{k=1}^{N} q_k\frac{q_T}{r_{kT}}+K\sum_{m=1}^{N} q_m\frac{q_T}{r_{mT}}-K\sum_{i=1}^{N} Q\frac{q_T}{r_i}-K\sum_{j=1}^{N} Q_{sj}\frac{q_T}{r_{jT}}-\sum_{n>1}^{N}\sum_{p=1}^{N'} q_T\frac{q^{n-1}}{32\pi^2 m^2\omega_0^3 R_{pqT}^6}-\alpha\frac{e^{-\mu r}}{r}+E_{VC}\ldots\ldots(9)$$

$$U_T(r)=q_T\Big(K\sum_{k=1}^{N}\frac{q_k}{r_{kT}}+K\sum_{m=1}^{N}\frac{q_m}{r_{mT}}-K\sum_{i=1}^{N}\frac{Q}{r_i}-K\sum_{j=1}^{N}\frac{Q_{sj}}{r_{jT}}-\sum_{n>1}^{N}\sum_{p=1}^{N'}\frac{q^{n-1}}{32\pi^2 m^2\omega_0^3 R_{pqT}^6}\Big)-\alpha\frac{e^{-\mu r}}{r}+E_{VC}\ldots\ldots(10)$$

This is the total resultant potential energy $U_T(r)$ or resultant amount of energy required to kick out the electron from the atom of an material before incident of photon. Since these resultant potential energy is an amount of energy to bind the electron and refer to work function, which are not allowing the electron to goes out side of the surface of the material.

Taking the individual effect some of the potential energy is only considerable for work function listed on equation 10, but here we are considering all effect i.e. resultant potential. Here, resultant potential is define as the potential whose effects are considerable by surrounding, atom, electron, nucleus which is either nearer or far from the electron which is going to be kick out from the consider atom. In this paper, we consider the resultant potential energy as work function of an atom of material made up of same atom. The resultant potential $U_T(r)$ needed to kick out the target electron from the atom is given by equation (7). Now, According to Einstein Photoelectric Equation

We have ,

$$hf_1=hf_2+K.E\ldots\ldots\ldots\ldots(11)$$

Where, hf_1 is incident energy of photon on the target electron which is going to be kick out from the atom of material and hf_2 is the work function of the material or atom which refer the binding energy of electron or potential energy.

Since by definition of resultant potentials and work function are same of a material then we have,

$$hf_2=U_T(r)\ldots\ldots\ldots\ldots(12)$$

Now, from Photoelectric Equation (11) and (12)

We get,

$$hf_1=U_T(r)+K.E\ldots\ldots\ldots\ldots(13)$$

On putting the value of $U_T(r)$ from (7) in (13)

We get,

$$hf_1=U_{PEQ}(-q_T)+U_{PEQsj}(-q_T)+U_{PEqk}(-q_T)+U_{PEsm}(-q_T)+U_{VDWP}(-q_T)+U_{YP}(-q_T)+E_{VC}+K.E\ldots\ldots(14)$$

Now on putting the value from (1), (2), (3), (4), (5), (6), and (7) in (14)

We get,

$$hf_1=q_T\Big(K\sum_{k=1}^{N}\frac{q_k}{r_{kT}}+K\sum_{m=1}^{N}\frac{q_m}{r_{mT}}-K\sum_{i=1}^{N}\frac{Q}{r_i}-K\sum_{j=1}^{N}\frac{Q_{sj}}{r_{jT}}-\sum_{n>1}^{N}\sum_{p=1}^{N'}\frac{q^{n-1}}{32\pi^2 m^2\omega_0^3 R_{pqT}^6}\Big)-\alpha\frac{e^{-\mu r}}{r}+E_{VC}+K.E\ldots\ldots(15)$$

Where,

$$hf_2=q_T\Big(K\sum_{k=1}^{N}\frac{q_k}{r_{kT}}+K\sum_{m=1}^{N}\frac{q_m}{r_{mT}}-K\sum_{i=1}^{N}\frac{Q}{r_i}-K\sum_{j=1}^{N}\frac{Q_{sj}}{r_{jT}}-\sum_{n>1}^{N}\sum_{p=1}^{N'}\frac{q^{n-1}}{32\pi^2 m^2\omega_0^3 R_{pqT}^6}\Big)-\alpha\frac{e^{-\mu r}}{r}+E_{VC}$$

is the work- function of a material or resultant work-function of consider material.

4 RESULT AND DISCUSSION

Here we are considering the resultant potential and refer it as work function of an atom of a material made up of same atom. The resultant potential $U_T(r)$ is refer hf_2 as a work function of material similar as Einstein Photoelectric Effect. When photon incident on the target electron which is going to be kick out from the material, certain amount of energy out of total energy of incident photon is used to make the electron ready to kick out from surface and remain energy is given to this electron for kinetic energy. This distribution of the energy is only possible if incidence photon has tiny segment photon. To kick of the electron the total energy of incident photon is equal or greater than $U_T(r)$.

Case I: If the energy of incidence photon is either same or a little slightly greater then work function, the time delay between incidence photon on target electron and kick out the target electron from the surface is slightly larger. Also the kinetic energy of kick out electron is less, because of less energy of incident photon is distribute to resultant potential or work function and after then only little amount of energy remain and these are transfer to the electron for kinetic energy.

Case II: If the energy of incidence photon is greater or more greater then work function, the time delay between incidence photon on target electron and kick out the target electron from the surface is less then in case I. Also the kinetic energy of kick out electron is larger, because of high energy of incident photon is distribute to resultant potential or work function and after then remain energy are transfer to the electron for kinetic energy.

The total energy of incident photon is distribute to provide the resultant potential, which is binding energy of electron in material. The distributing of a single photon energy to number of factor or potential which binding the electron is only possible if single photon has number of tiny segment photon. This is because the electron take time to kick out from surface when photon incident on it. If incident photon don't contain tiny segment photon then time needed to kick is zero. The supply of the energy to the electron is in discrete packet by single incident photon.

The factor effecting the work function are listed in short are given below:

- Attraction between nucleus of an atom and target electron of same atom.
- Conversion of proton into neutron and Neutron inside the nucleus.
- Attraction between nuclei of surrounding an atoms and target electron atom which is going to kick out from an atom of material.
- Repulsion between an electron of surrounding atom and target electron which is going to be kick out from an atom of material.
- Energy gap between conductance and valance band.
- Van Der Waals Potential.

5 CONCLUSION

Hence due to theses number of factors the time delay can be seen when photon incidence on the electron of the material and kick out the electron which is on target. The time delay show the energy supply of incident photon to electron for a certain time is to take the electron on the surface and the remain energy supply the electron when electron comes on surface and ready to go out of surface for photo electric current or photo electric effect. This time delay can seen more clear only if we consider all the effect that bounded or bind the target electron which is going to kick out. In this way, we can say that factor effecting work function, causes time delay to kick electron from material when photon incidence on electron. On considering this all effect, we can also conclude the nature or properties of tiny segment photon contain by incident photon.

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