Practical Significance of Surface Ion Effects in Solids

Aminov Shodibek Yuldoshevich[1]

[1]Termiz State University. Teacher of the Department of General Physics

ABSTRACT

Adsorption of an atom or molecule on the surface of an inflamed solid body or diffusion out of the solid body and the establishment of thermodynamic and charge balance between the adsorbed particle and the solid body, and thermodesorption of particles from the surface of the solid body. During thermodesorption, the charge state of the particles is determined. The charge state of a desorbed particle is determined by the isothermal electron exchange between the particle and the solid. In this paper, the main condition is that the occurrence of the phenomenon without changing the thermoemission properties of the surface of the adsorbed particles falling on the surface.

It is known that the surface ionization occurs due to the desorption of particles that are adsorbed on the surface of the heated solid in the supercharged or neutral state. In the case of surface ionization, desorption is performed. The surface ionization phenomenon is a equilibrium phenomenon, and the resulting particles are subject to the Maxwell-Boltzmann distribution
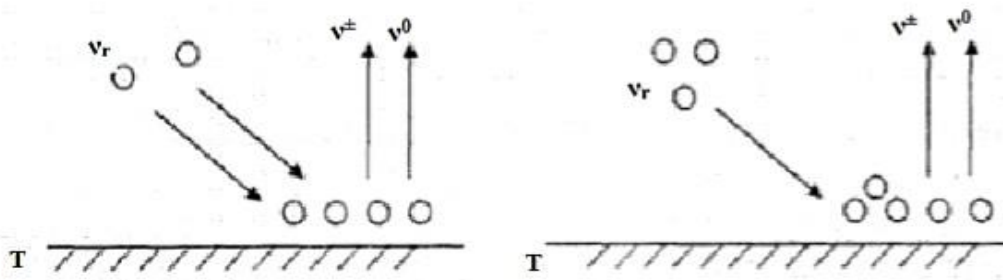

Figure 1. Surface ionization phenomenon

The surface ionization phenomenon involves the following 3 steps.

1. Adsorption of an atom or molecule on the surface of an inflamed solid or diffusion out of the solid.

2. Adsorbed particles and solids; establishing thermodynamic and charge balance between objects.

3. The solidity of the particles; thermodesorption from the surface of the body.

During thermodesorption, the charge state of the particles is determined.

At a critical distance from the surface, a solid body that is initially unique - the particle system - is divided into separate - solid - solid bodies and particle systems.

The charge state of a desorbed particle is determined by the isothermal electron exchange between the particle and the solid.

The particle becomes a positive ion if its valence electron V passes from the energy level to the empty surface in the conduction band of the solid, i.e. the ionization potential is less than or equal to the work function eV≤eph. Otherwise the electron exchange does not take place and the particle leaves in a neutral state, i.e. eV≥eph.

As the temperature increases, the density distribution of electrons changes and, accordingly, the isothermal electron exchange changes. Basic emission relations of surface ionization of atoms and molecules. In the case of surface ionization, mainly 2 sizes are used:

$$\infty = \frac{V^+}{V^0}$$

a) degree of ionization

$$\beta = \frac{V^+}{V}$$

b) ionization coefficient

Here V is the flux of particles falling to the surface, V^+ and v^0 are the flux of positive and neutral particles desorbed from the surface, respectively. The flow of particles falling under the conditions is equal to the flow of particles leaving the surface. Using this, it is possible to determine the relationship between the surface ionization rate and the coefficient:

$$\beta = \frac{v^+}{v^+ v^0} = \frac{2}{1 + \frac{v^0}{v^+}} = \frac{1}{1 + \frac{1}{\alpha^2}} = \frac{\alpha}{1 + \alpha}$$

(1)

For the surface ionization of atoms, the surface ionization rate is determined by the Saha-Langmuir formula when the electric field strength on a homogeneous surface is $E= 10\ B\ sm$:

$$a = A \exp \frac{\partial}{kT} [\varphi + \sqrt{eE} - V]$$

(2)

Here $A = \frac{Q^+}{Q^0} -$ The ratio of the statistical sum of charged and neutral particles when the temperature of a solid is ^{T}: e is the charge of the electron, $^\varphi$ is the work function of the surface, ^{V} is the ionization potential of the particle, ^{k} is the Boltzmann constant, ^{E} is the electric field strength, ^{T} is the emitter temperature.

In general, the current of ions is determined using the following relationship:

$$J = ev^+ S(1 + R) = ev\beta(T)(1 - R)S$$

(3)

where ^{s} is the surface area of the emitter desorbed part of the emitter, ^{R} is the coefficient of return of the particles from the metal-vacuum boundary. Pulling of charged particles from the surface is done using an external electric field. In these cases, the adsorbed particles do not change the emission and adsorption properties of the surface, and the surface coverage of the surface with foreign particles is calculated as $\emptyset \leq 0.001$.

The following expression can be written for the ion current:

$$J = \frac{\partial A v S}{A + \exp \frac{\partial}{kT} [V - \varphi - \sqrt{eE}]}$$

(4)

(4) shows that the surface ionization process depends on the relationship between the surface work function and the ionization potential of the desorbed particle.

The following two cases can be distinguished:

$$e(V - \varphi - \sqrt{eE} \ll kT)$$

1. Slightly ionized state:,

$$a \gg 1, \beta \leq 1$$

ie.

In this case, most of the adsorbed particles are desorbed by ionization. In formula (4) the second limit in the denominator is suddenly

large enough and therefore the current of the ions is determined as follows:

$$J(T) = evS \quad (5)$$

in other words, the ions remain independent of temperature.

    1. Difficult ionization state:

$$e(V - \varphi - \sqrt{eE} >> kT) \quad \text{ie} \quad \alpha << 1, \beta << 1$$

In this case, a small part of the atoms falling to the surface is ionized. For the case of difficult ionization, the relation (4) is written as follows:

$$J = eAvS \ \exp \frac{\partial}{kT}(\varphi + \sqrt{eE} - V) \quad (6)$$

It can be seen from the expression obtained that as the emitter temperature increases, the current of the ions also increases. The main condition is that the adsorbed particles falling on the surface should not change the thermoemission properties of the surface. At temperatures below the threshold temperature T, the coverage coefficient increases and the output function decreases, the desorption heat of the ions increases, the desorption heat of the atoms decreases, and we cannot see the ionization of the particles.

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