HIGH ENERGY PLASMON SATELLITES IN THE X-RAY EXCITED AUGER SPECTRA OF SOLIDS

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The present research work has been prompted by the recent paper of Landers et al. [1]. They have observed several satellites on both the sides of $L_3M_{4,5}M_{4,5}$ main line in the auger spectra of Ag ,Pd , Rh, Mo and Nb elements. They have identified the structure on the low energy side as arising from shake-up involving spectator valence band holes, whereas the structure on the high energy side have been explained by atomic model using intermediate coupling calculations. However, in another paper [2] they have reported that the agreement between experimental intensities and calculated intensities is not good.

Brouers [3] has pointed out that plasma excitation during X-ray emission process is the collective counter part of the usual auger effect in which the primary x-ray transition excites a secondary electron. Hence plasma involvement in the satellites may also be present.

Further Ferrell [4], Noziers and Pines [5] Houstan and Park [6] and Mahan [7] have pointed out that the interpretation of x-ray emission absorption and auger spectra etc. must take into account the contribution of the interaction between suddenly created or annihilated core holes to the collective mode of the conduction electrons. This interaction produces a structure, which is displaced from the principal structure by an energy h/2p (known as plasma energy).

In the present research work the author has used the plasma theory to explain high energy satellites in $L_3M_{4,5}\ M_{4,5}$-Auger spectra of 4d transition metals. The plasma energy due to the electron density fluctuation of the bulk is known as the volume plasma energy. The plasma energy is given by Morton et.al. [8]:

$DE_P = h/2p\ w_P = 2.88\ (Z.s\ /\ W)^{1/2}$ e.V. …. (1)

Where Z the effective number of electrons taking part in the plasmon oscillations, is the specific gravity and W is the molecular weight.

The energy of the surface plasma is given by

$DE_S = h/2p\ w_S = h/2p\ w_P/Ö2$ …..(2)

Langreth [9], Chang and Lengreth [10] have developed a general theory to explain the factors, on which the relative intensity of plasma satellites depends. It depends upon the mode of excitation, one is intrinsic and the other is extrinsic. In the extrinsic process, the excitation of plasma occurs during the transport of the electron through the solid. Whereas in the intrinsic process excitation of plasma take place simultaneously with the creation of hole. Extrinsic is the fast process whereas intrinsic is slow. The author is interested in the intrinsic process only. Bradshaw have further divided the intrinsic process into two categories, one where the number of electrons is conserved and the other where the number of electrons is not conserved. Plasma satellites are weak in conserved case and ten times stronger in non-conserved case. Langreth [9] and Bradshaw [11] have given the relative intensity of the peak with respect to the main emission line in the intrinsic process as-

$i = 0.12 r_s$ ...(3)

whereas r_S is a dimensionless parameter ,given by,

$r_S = (4.711/hw_P)^{2/3}$ for bulk plasmon ..... (4)

and $r_S = (4.711/hw_P)^{2/3}$ for surface plasmon ...... (5)

Langreth, Chang and Langreth further modified the expression for relative intensity by taking into account the effect of slow -fast interference term. Modified intensity is given as-

$i = 0.12 r_s - 0.1$ ....(6)

The author has calculated the bulk plasma energy of Ag by using Eq .(1) and surface plasma energy of Pd, Rh, Ru, Mo and Nb elements by using Eq. (2). Estimation of energy separation of IInd peaks onnthe high-energy side of $L_3 M_{4,5} M_{4,5}$ main emission line ,has also been done from fig. 1,the spectra of these metals obtained by Landers [1]. The calculated and estimated values, as given in table -1,are in good agreement. Energy considerations alone suggest that IInd peaks on the high energy side of the main line are surface plasma satellites in case of Pd, Rh, Ru , Mo and Nb elements and bulk plasma satellite in case of Ag.

For further confirmation, the relative intensities of high energy plasma satellites have been calculated using Eq. (3) and Eq.(4) for Ag and Eq. (5) and Eq.(6) for Pd, Rh, Ru, Mo and Nb elements. The author has also estimated the relative intensities of IInd peaks on the high-energy side of the main line obtained by Landers et. al . [1]. The calculated and estimated values agree fairly well. Hence relative intensity considerations further confirm that IInd satellites on the high energy side are due to surface plasma, in case of Pd, Rh, Ru, Mo and Nb elements whereas in case of Ag it is due to bulk plasma. According to Langreth [9] when the effect of surface is of about the same magnitude as the slow- fast interference term, then it decreases the strength of bulk satellites. This may be the reason here.

Thus the author concludes that the IInd satellites on the high energy side of the main emission line in Landers [1] curves, are surface plasmon satellites in case of Pd, Rh, Ru, Mo and Nb elements whereas it is bulk plasmon satellites in case of Ag. While the explanation given by Landers [1] may also be true.

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