ISSN:0976-4933
Journal of Progressive Science
Vol.11, No.01 & 02, pp 44-47 (2018)

High energy double plasmon satellite in transition metal

Sameer Sinha, Rajeev Kumar Srivastava, Ajay Vikram Singh *
Department of Physics
Ganpat Sahai Post Graduate College, Sultanpur, U.P., India
***Rajarshi Rananjay Sinh Institute of Management & Technology, Amethi ,U.P., India**

Abstract

Energy separation and Relative intensity of surface plasmon satellites of X-ray emission line of transition element have been calculated. The theoretical values are fairly close with the values estimated from Poonia Surendra and Soni (2007)

Keywords- Surface Plasmon satellites, Relative Intensity & Energy Separation

Introduction

Multiple plasmon loss peaks in the energy loss spectrum of fast charged particle, after passing through a thin metallic foil were interpreted as due to multiple scattering of single plasmon process in these interpretation the possibility of multiple plasmon excitations in a single scattering process was totally ignored. In 1970 Ashley and Ritchie calculated for the first time the probability of double plasmon excitation in a single process and found that at an energy distance of $2\hbar\omega_p$ two processes will contribute

Single plasmon $\hbar\omega_p$ scattering two times

Double plasmon scattered one time.

Multiple plasmon loss peaks have been observed in soft X-ray appearance-potential spectra (SXAPS) by Bradshaw and Mensel (1973), in characteristic energy loss spectra by Von Koch (1970) and Henrich (1973) in Auger spectra by Jenkins *et al.* (1971-1973) and Dufour *et al.* (1972) and in photo emission spectra by Smith and Spicer (1969) During the last two decades several workers (1973,1975 have also observed X-ray satellites at an energy distance of $2\hbar\omega_p$ from the main emission line . Although Arakawa and Williams (1973) have tried to explain such satellites due to double ionization process , initially proposed by Hayasi (1969) but Asley and Ritchi's (1970) theoretical calculation

, and Spence and Spargo's (1971) experimental work led us to assign the aforesaid X-ray satellites as double plasmon satellites.

Mathematical calculation

To support the above idea the author has calculated the energy quantum of double plasmon emission using the following formulae

For double mode of excitation of surface plasmon

$\Delta E = 2\hbar\omega_s$

$$\mathbf{\Delta E = 28.8\sqrt{2\left(\frac{Z'\sigma}{W}\right)^{1/2}}\ eV} \qquad (\mathbf{1})$$

And for double mode of excitation of bulk plasmon .

$$\Delta E = 2\hbar\omega_p = 57.6\sqrt{\left(\frac{Z'\sigma}{W}\right)^{1/2}} \quad eV$$

$$where \quad \hbar\omega_s = \frac{\hbar\omega_p}{\sqrt{2}} \quad \text{and} \quad \hbar\omega_p = 28.6\sqrt{\left(\frac{Z'\sigma}{W}\right)^{1/2}} \quad eV$$

Where Z' is the number of unpaired electrons taking part in plasma oscillations, σ is specific gravity and W is molecular weight.

Further Tulkki *et al.* (1981) have also observed some X-ray satellites but we have explained $L\alpha_2$ satellites which are at energy distance $2\hbar\omega_p$ respectively from plasmon theory We would guess on the first sight the involvement of plasmon excitation in these satellites from the energy separation of these satellites alone

Our calculated values of ΔE have been compared with the Tulkki *et al.* (1981) experimental value. And that have also calculated the relative intensity of plasmon satellites, which is different in different processes. If the excitation of plasmon occurs during the transport of the electron through the solid, it is known as extrinsic process of plasmon excitation. The plasmon can also be excited by another method known as intrinsic process. In this process, excitation of plasmon takes place simultaneously with creation of a hole. Bradshaw et al have further divided core hole excitation into two classes,

1 - Where the number of slow electrons are conserved.

2 - Where the number of slow electrons are not conserved

The Author has calculated relative intensity of high energy double plasmon satellites as

$$i_{2\hbar\omega_p} = \frac{\alpha^2}{4}\frac{1}{\sqrt{\beta}}\tan^{-1}\sqrt{\beta}$$

$$\text{where} \quad \alpha = \left(\frac{e^2 k_c}{\pi \hbar \omega_p}\right) \quad \text{and} \quad E = \frac{k_c}{k_F}$$

$$\alpha = 0.166\, r_s \quad \text{and} \quad \beta = 0.814 r_s^{1/2}$$

Energy sepration ΔE high energy double plasmon satellites of $L\alpha_2$ X-ray emission line of transition element

S. No.	Name	Z	W	σ	Exp. Value of Double Plasmon (Lβ1")	Author Value of Double Plasmon (Lβ1") 2 ħws
1	Nb(41)	1	92.906	8.58	12.41ev	12.20ev
2	Mo(42)	1	95.94	10.28	13.49ev	12.40ev
3	Ru(44)	1	101.07	12.45	13.56ev	13.20ev

Relative Intensity of high energy double plasmon satellites of $L\alpha_2$ X-ray emission line of transition element

S.No.	Name	Author calculated value $i_{2\hbar\omega_p} = \frac{\alpha^2}{4}\frac{1}{\sqrt{\beta}}\tan^{-1}\sqrt{\beta}$	Exp. Value given by Tulkki's et al
1	Nb(41)	1.19265	1.210909
2	Mo(42)	1.34389	1.368272
3	Ru(44)	1.29563	1.318182

Conclusion

We have calculated Relative intensity of high energy double plasmon satellites of $L\alpha_2$ X-ray emission line of transition element and compared with the experimental values of Poonia and Soni .Thus for these satellites both theory can be equally good. Hence we have established beyond doubt that the observed satellites $L\alpha_2$ may be due to absorption of double plasmon

References

1. Arakawa, E.T. and Williams, M.W. (1973). Phys.Rev.B84075.
2. Ashley, J.C. and Ritchie, R.H. (1970). Phys.Status Solidi 38 425.
3. Bradshaw, A.M. and Wyrobisch, W. (1975). J.Elect.Spectrose relat.Phenon.7a 45
4. Bradshaw, A.M. and Menzel, D. (1973). Phys. Status Solidi (b) 56,135.
5. Dufor, D., Guennou H. and Bonnell, C. (1972). Surf. Sci. 32 731
6. Henrich, V.E. (1973). Phys. Revs.B7, 3512.
7. Hayasi, Y. (1969). Sci.Rep.Tohoku Univ. 51(1968). 51-52) 769
8. Jenkins, L.H., Zehner, D.M. and Chung, M.P. (1973). Surf. Sci.38327.
9. Jenkin, L.H. and Zehner, D.M. (1973). Solid State Commun. 12) 1149.
10. Jenkins, L.H. and Chung, M.P. (1971). Sur.Sci. 26:151
11. Poonia, Surendra and Soni, S.N. (2007). Indian Journal of Pure and Applied Physics. 45,(Feb.) :119-126
12. Smith, N.V. and Spicer, W.E. (1969). Phys. Rev.Lett. 23,769
13. Spence, J.C.H. and Spargo, A.E. C. (1971). Phys. Rev. Lett. 26895.
14. Srivastava, K.S. (1996). Indian Journal of Pure and Applied Phy.,vol 34,March: 190-192
15. Tulkki, J. and Keski, O. (1981). Rahkonen Phys. Rev. A24 849-853
16. Von Koch, C.A. (1970). Phys.Rev.Lett 25 792.

Received on 20.07.2020 and accepted on 19.11.2020