The Electron Mean Free Path for Volume Plasmon Excitation in Polycrystalline Beryllium

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Reflection electron energy loss spectra from polycrystalline beryllium for primary electron energies within 100–1 000 eV are measured. The peak intensities increase with the primary energy. From this dependence the electron mean free path for volume plasmon excitation in beryllium is evaluated.

Key words: Beryllium, electron mean free path, reflection electron energy loss spectra, volume plasmon, elastic peak.

The dependence of reflection electron energy loss (REEL) spectra of aluminium on the primary electron energy has been studied by Koval et al. [1, 2], who also proposed a method for the evaluation of the electron mean free path for volume plasmon excitation from such data. In the present work the method presented in [1] is used for the evaluation of the electron mean free path for volume plasmon excitation in polycrystalline beryllium from REEL spectra obtained with primary electron energies in the range 100–1 000 eV.

Experimental

The REEL spectra were obtained with a homemade cylindrical mirror analyzer (CMA) [3]. The pressure within the apparatus was 5×10^{-10} Torr. For cleaning the sample was bombarded with K^+-ions and heated. After this treatment a very strong line at 104 eV was observed in the AES spectrum and attributed to the Be KVV Auger transition. Weak Auger peaks were attributed to spurious O and C. The cleaning procedure for beryllium using potassium ion bombardment from a zeolite source was outlined in [4]. The REEL spectra were obtained in the first derivative mode (using $V_{p-p} = 0.5$ V) in order to substract the continuous background of inelastically reflected electrons. The current of the primary electrons was kept constant. It is known that in the first derivative mode the measured signal at the output of the CMA is proportional to $EN(E)/dE + E$, but for small modulation signals the measured signal is proportional to $dN(E)/dE$ [5]. Since the detected yield is affected also by the CMA intrinsic resolution, the direct REEL data should be corrected. In our case, however, this was not necessary because we are interested in their trends only.

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Results

The obtained REEL spectra were already presented in [4] and are shown in Figure 1. The main features of these spectra can be summarized as follows: The rela-

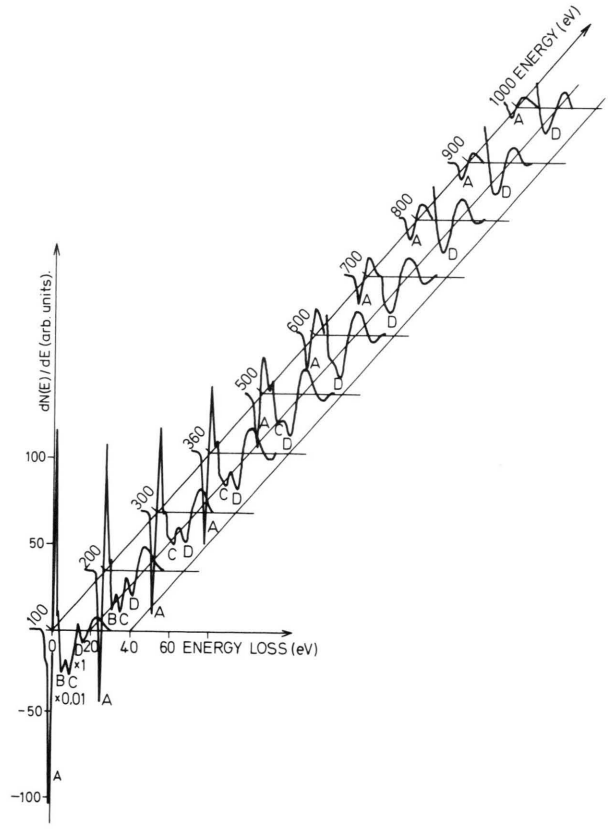

Fig. 1. REEL spectra of polycrystalline beryllium for primary energies 100–1000 eV [4]. A: elastic peak, B: interband transition peak, C: surface plasmon peak, D: volume plasmon peak.

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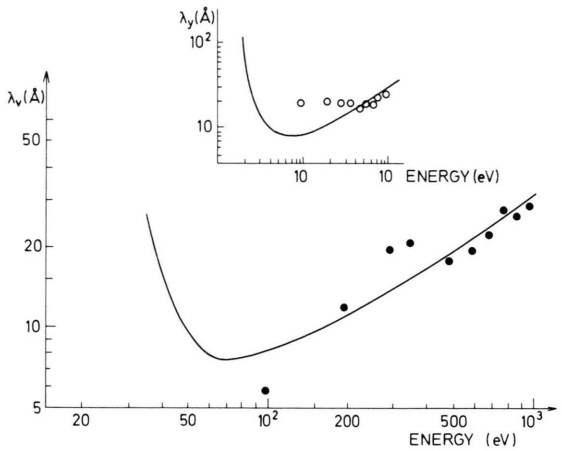

Fig. 2. Dependence of the electron mean free path for volume plasmon excitation in polycrystalline beryllium on different energies of primary electrons. The solid line presents the theoretical data of Quinn [7]. Insert: Results of Koval et al. [1] for aluminium.

tive intensity of volume and elastic peaks changes with the primary electron energy while no energy shift of plasmon excitations occurs in the experimental energy range.

According to the procedure outlined in [1] there exist relations between the intensities of the volume plasmon (I_V) and elastic peaks (I_0) and the electron mean free paths without energy loss (λ_0) and for volume plasmon excitation (λ_V). The intensities of elastically reflected electrons and of electrons which have lost discrete energy quanta for volume plasmon excitation were calculated, assuming Gaussian elastic and volume plasmon peaks, according to the formula $I = \sqrt{2\,\Pi\, e} \times hz^2/8$, where h denotes the peak height and z the energy separation between maximum and minimum of the peak in the energy distribution derivative. The λ_0 values were calculated using the formula of Seach et al. [6]. In Fig. 2 the dependence of the electron mean free path for volume plasmon excitation on the primary electron energy for beryllium is presented. The solid line corresponds to the theoretical data using Quinn's equation [7].

Conclusion

The calculations based on our intensity measurements are in quite good agreement with the theoretical results only for energies larger than 400 eV. For smaller energies the agreement is poorer although not very bad, likewise as in [1]. One of the possible reasons is the inadequacy of Quinn's theoretical approach in this energy range.

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