Role of surface excitations in electron spectroscopy and secondary electron emission

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The influence of surface excitations on electron spectra is reviewed and results on the contribution of surface plasmon *decay* to secondary electron spectra are presented. Using the concept of the partial intensities, accurate separation of the contribution of multiple surface and volume scattering in an experimental spectrum can be achieved. This method is applied to study various phenomena related to surface excitations. Experimental results accurately confirm that the probability to experience a surface excitation is proportional to the time the electron spends in the surface scattering zone. Furhermore, the coupling between surface and volume excitations can be observed in this way and the existence of super-surface electron scattering can be directly confirmed. These results make it necessary to introduce a novel physical quantity, the so–called "inelastic reflection coefficient for surface excitations" to consistently describe electron scattering near surfaces.

The *decay* of surface and volume plasmons has been studied by measuring spectra of secondary electrons (SE) in coincidence with primary electrons that have suffered a given energy loss, allowing one to distinguish in detail those energy loss processes that give rise to the emission of secondaries. In the case of Al, such spectra are dominated by surface and volume plasmon decay, along with a contribution due to electron–electron scattering (see Fig. 1). The mere existence of plasmon decay peaks indicates that in the majority of cases the energy liberated during plasmon decay is transfered to a *single* electron. From these results, it is possible to estimate the fraction of secondaries that are generated as a result of surface plasmon decay. For 500 eV primary electrons this fraction amounts to ∼30%. The coincidence measurements also provide detailed information concerning an electron's trajectory *inside* the solid, since individual inelastic processes along the trajectory are detected. The results obtained so far explicitly confirm the common hypothesis that multiple scattering inside the solid follows a Markhov-type process.

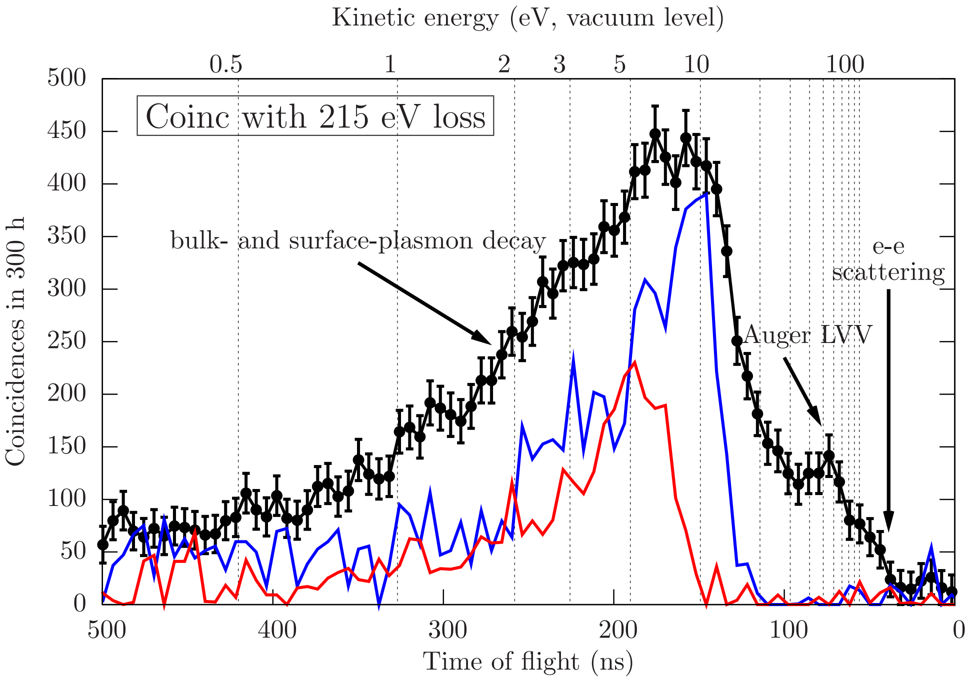

Figure 1. Secondary Electron (SE) spectrum measured in coincidence with electrons backscattered from a polycrystalline Al sample after experiencing an energy loss of 215 eV.The blue and the red curves represent the contribution of bulk- and surface-plasmon decay, respectively. The contribution of direct electron–electron scattering extends up to the energy loss of the primary electron, indicated by the vertical arrow. Superimposed on the latter, an LVV-Auger transition is seen.

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