ACOUSTIC SURFACE PLASMON ON A METAL SURFACE WITH ADLAYERS

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A variety of metal surfaces such as (111) surfaces of noble metals Cu, Ag, and Au, and Be(0001) are known to support a partially occupied electron bands of the Shockley surface state at the center of the Brillouin zone. This state has a parabolic-like dispersion with two-dimensional (2D) momentum parallel to the surface and their wave functions are strongly localized at the nanometer scales near the surface. Therefore they are considered to form a quasi two-dimensional surface-state band with a 2D Fermi energy ε_F^{2D} equal to the surface-state binding energy at the $\overline{\Gamma}$ point. Indeed the surface states are immersed in the sea of bulk electrons and the charge corresponding to surface states constitutes only a small fraction of total electronic charge at metal surfaces. However, due to its 2D character this surface state can strongly modify the dielectric properties of surfaces. Recently it has been demonstrated that due to the coexistence of carries near the surface in bulk and surface bands there is a possibility for existence of a novel kind of collective electronic excitations – acoustic surface plasmon (ASP).

An interesting property of the ASP is its quasi-linear dispersion with momentum parallel to the surface, q, for small values of q. The slope of the dispersion is determined by the Fermi velocity of the surface state, which could be changed by altering the filling of the surface state band. Thus the ASP dispersion can be tailored in a wide range. One way to alter the Fermi velocity is to adsorb species on the surface. For instance, many alkali atoms covered metal surfaces are known to induce a partly occupied nearly free electron-like band, a quantum well band. In this contribution we demonstrate how this quantum well band generates ASP excitations taking as examples, the Na/Cu(111) and K/Be(0001) systems.

We present results of a self-consistent calculation of the surface loss function for these systems with the inclusion of realistic surface band structures. In the case of the Na/Cu(111) system we investigated how the results depend on the Na coverage, whereas for the K/Be(0001) comparison between the model and ab initio calculations will be made.