Positron states in nanocrystal metals

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Under these conditions, the interface of a NP can give rise to size – quantization of the quasiparticle energy spectrum of the NP due to the purely spatial limitation of the region of quantization and the polarization interaction of charge carriers with the NP surface [2,3]. The optical properties of quasi – zero – dimensional structures are largely determined by the energy spectrum of charge carriers localized by electrostatic image forces near the interface between two different diekectric media [4,6].

A theory of macroscopic local single – particle charge states in quasi – zero – dimensional structures is framed. The energy spectrum of charge carriers in a small particle (semiconducting, dielectric or metal) is investigated as well as its dependence on the size of the particle, the effective mass of the charge and relative dielectric constant under conditions when polarization interaction plays an important role [1-3]. A new type of local states of charge carriers inside a small particle, namely surface states, is predicted [2,3].

Though the results of the variational calculation refer only to the case *n=1*, it can be expected, however, that for $n > 1$ the spectrum $E_{nl}(a)$ will have an analogous character of dependence on *a* and *l*.

The pattern of the $E_{nl}(a)$ spectrum in the latter case can be investigated by the WKB method for arbitrary values *n* and *l* which can yield correct results for arbitrary values of *n* and *l* [3]. A limiting transition to an accurate Coulomb spectrum as well as to the spectrum of a particle moving finitely within a spherical potential well of infinite depth in the applicability region of these spectra at arbitrary *n* and *l* can be obtained from the quantization condition by using an exact solution of the Schrodinger equation at $r \to 0$ to find the phase in the quasi – classical wave function; the potential *U(r,a)* has Coulomb form and also an explicit form of the radial wave function of "free" motion of the charge carrier limited only by DP walls.

The dependence of the spectrum $E_{nl}(a)$ of macroscopic linked states of positron located in the bulk of spherical nanocavity of radius *a* of nanocrystal metals on the radius *a* of a cavity, where principal *n* and orbital *l* quantum number are arbitrary is theoretically studied [4-6] (new sensor method). The possibility of experimental study of states of positron located in nanocavity is being considered.

The simplest method of detecting and studying the considered positron of states in small NP can be the investigation of interband light absorption with the formation of one of the carriers in a bound state [4-6]. Owing to the strong difference in binding energies and critical dimensions for various charge carriers the quantum energy for such transitions is

$$h\omega(a) = E_g + E_{nl}(a) < E_g,$$

(E_g is the energy of the forbidden band), as in such a process the conditions are available for localization of only one of the carriers. The dependence of $E_{nl}(a)$ on the dimensions of the particle *a* and its threshold character allow to select by laser spectroscopy methods those microinhomogeneities which are microcrystals of semiconductors and metals [4-6].

It should be stressed that a large value of b_2 (here b_2 the average distance of the charge localized over a plane surface in the ground state) characterizing the dimension of the state ($\geq n^2 b_2$) provides low sensitivity to the details of the interface structure and to slight deviations from sphericity [4].

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