

ELECTRON ENERGY AND POTENTIAL EVOLUTION IN MIS AND MISIM

STRUCTURES

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We have determined the energy E_0 of the electron ground state in a MIS (Metal-Insulator-Semiconductor) structure by varying both the total energy and electrostatic energy functionals which represent an approximate self-consistent solution of Schrödinger and Poisson's equation, assuming all electrons at semiconductor inversion layer are in the ground state¹⁾. The numerical results for E_0 and the average distance z_{av} of electrons from the I-S interface are given in Table 1, with the total number of electrons (N_0) in the inversion layer per unit area as a parameter. One can see a good agreement with the more precise, but more laborouse procedure²⁾

E_0 and z_{av} for (111) p-Si, $N_A = 10^{21} m^{-3}$, $T = 77^\circ K$. Table 1

$N_0 [m^{-2}]$	Accord to 2)				Our variational method	
	by variational method		numerically		$E_0 [meV]$	$z_{av} [nm]$
	$E_0 [meV]$	$z_{av} [nm]$	$E_0 [meV]$	$z_{av} [nm]$		
$1 \cdot 10^{14}$	20.60	7.03	19.53	6.53	20.42	7.04
$2 \cdot 10^{14}$	21.34	6.96	20.28	6.56	21.05	6.97
$5 \cdot 10^{14}$	23.50	6.78	22.48	6.38	22.89	6.80
$1 \cdot 10^{15}$	26.92	6.52	25.96	6.13	25.83	6.55
$2 \cdot 10^{15}$	33.28	6.10	32.35	5.72	31.32	6.14
$5 \cdot 10^{15}$	49.81	5.20	48.81	4.95	45.68	5.33
$1 \cdot 10^{16}$	72.74	4.52	71.50	4.26	65.74	4.58

For the electron in the accumulation layer of a MISIM

(Metal-Insulator-Semiconductor-Insulator-Metal) structure (Fig. 1) we suppose the following form of the macroscopic potential in the semiconductor

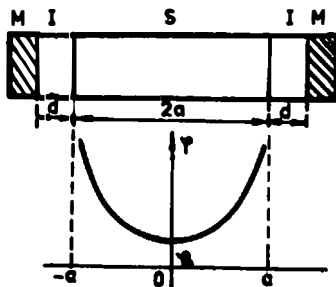


Fig. 1.

wave function and ϕ we obtain

$$C e_n \left(\frac{\beta a}{2}, \theta \right) \approx 0 \quad \text{and} \quad \varepsilon \phi_0 \beta \text{sh} \beta a = e N_s \quad (3a, b)$$

where N_s is the surface charge density.

The quantity ϕ_0 may be determined classically³⁾, which enables to find the energy of electron $E(\phi_0, \beta)$ using Eqns. (3a) and (3b). The self-consistent potential could now be evaluated solving the Poisson equation.

The numerical resolving of this problem is in course.

REFERENCES

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