The ambipolar continuity equations defined on can be given as

where the flux term is defined as

where and , and the source term is given by

respectively.

The flux describes the flow strength of carrier type subjected to the external electric biases. The external electric biases, as introduced below, and , manifest themselves in the boundary constraints. The boundary constraints are imposed by the implicit variables and , which are related to the master variables and via the transform

The transform is given by the system of the algebraic equations

where the newly introduced intermediate variable has the physical meaning of the electrostatic potential. In fact, the first equation represents the two-dimensional limits of the Poisson’s equation, the second and the third equations stand for the statistical function for the charged carriers in a non-equilibrium system. Other newly introduced constants involved include , , and . They are all positive-definite.

Initial condition

Boundary condition

Both initial conditions and boundary conditions can be converted into the forms written by via the transform .

Numerical experiments

|  |  |  |
| --- | --- | --- |
|  | Parameters | values |
| 1 |  | 773.634541436672e-006 |
| 2 |  | 773.634541436672e-006 |
| 3 |  | 3.23975816372672e+021 |
| 4 |  | 3.02377428614494e+021 |
| 5 |  | 24.9194653795352e+000 |
| 6 |  | 23.2581676875662e+000 |
| 7 |  | 7.54293677900755e+000 |
| 8 |  | 61.7330028639972e-030 |
| 9 |  | 66.1425030685685e-030 |
| 10 |  | 25.8519997864355e-003 |
| 11 |  | 39.0000000000000e-003 |
| 12 |  | 351.000000000000e-003 |

The external electrical biases function is set as

The PDE systems are solved by pdepe function implemented in MATLAB. The spatial mesh is generated by uniformally dividing the interval into 102 sub-intervals. The stop moment is set as , and temporal partition points are assigned.

The PDE solver “pdepe” basically returns the weak solution, which fulfils the integral form of the original differential equations. In our case considered here, we are just caught by the moment.

