EFFECT OF CACHODE DISPERSION ON TEMPORARY CHARACTERISTICS OF GAS DISCHARGE

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In the cathode layer of the DC discharge at reduced pressure of the gas, the ions acquire energy of the order of 200-300 eV, and therefore, if they hit a metal cathode, they are most likely knocked out of it an atom, i.e. there is a cathode sputtering, called plasma etching in microelectronics. To estimate and analyze the effect of this phenomenon on the time characteristics of a gas discharge, we adopt the following model:

1. a clean gas with a given flow rate:  - the number of atoms per unit time, enters to the gas-discharge tube from the high-pressure reservoir through the reducer;
2. a mixture (working gas and atoms of the atomized cathode) is discharged through the outlet valve to an empty tank at such a rate  as to maintain a predetermined pressure  that is composed of the pressure of the working gas atoms and the atomized cathode atoms;
3. the DC source supports a given current in the circuit  ;
4. the atoms of the working gas and metal after ionization are converted into ions and some of them bombard the cathode: ;
5. the gas ions, colliding with the surface of the cathode, knock out the metal atom from it with probability  , and they themselves are recharged and reflected back into the volume of the tube, i.e. when the cathode is atomized by gas ions (usually noble), there is no change in the number of atoms in the system;
6. metal ions, colliding with the surface of the cathode, knock out the metal atom from it with probability  , and they themselves remain in the cathode, doping it, i.e. when the cathode is atomized by metal ions, the total number of atoms in the tube can increase or decrease.

Within the framework of the above assumptions, balance equations for the concentrations of working gas atoms and metal vapors are written and analyzed for two cases [1, 2].

In the first - the gas-discharge tube is closed, gas - argon, cathode - iron or copper [1]. At the initial stage, the gas pressure increases linearly, because dominates the process of cathode sputtering with argon ions. As the concentration of metal vapors increases, the fraction of metal ions increases and cathode doping with iron ions compensates for the entry into the volume of metal atoms due to sputtering of the cathode.

In the second case, the influence of the gas pumping rate on the characteristics of a discharge with a hollow cathode of stainless steel at a given gas pressure (neon or argon) is considered [2]. An increase in the rate of gas pumping reduces the concentration of metal atoms in the tube and suppresses the effect of sputtering the cathode on the characteristics of the discharge.

References

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