Modeling Of Internal Mechanical Tension's Influence On Electric Strength Of M-D-M-structures Under Electric Breakdown

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Abstract - **Deformation changes of electric strength of M-D-M-structures under electric, ionization and electrochemical breakdown, caused by internal mechanical tensions, are modeling in the article. Determined mathematical models which take into account main mechanisms of internal mechanical tension's influence on M-D-M-structure's electric strength are represented**

Keyword - **Internal mechanical tensions, Deformation, Film, Electric strength, Electric breakdown**

I. INTRODUCTION

M-D-M-structures are one of the most wide-spread elements of IC, microassemblies and functional devices. Their electric strength influences substantially on integrated and functional device's reliability. In many cases it determines by thermal breakdown. An internal mechanical tension's (IMT) influence on thermal breakdown was already considered before in work [1]. In reference to electric breakdown, influence of IMT was not considered so far. This means that investigation of IMT influence on electric breakdown of M-D-M-structures is an actual.

II. MAIN PART

Rapid forming of the channel with high conductivity in dielectric as a result of cumulative ionization of neutral atoms by electrons is electric breakdown. For beginning of the cumulative ionization it is necessary to acquire by accelerated in electric field electrons the kinetic energy $E_к$ which is equal or greater from interaction energy with atom $E_{зв}$.

After analysis of the cumulative ionization's process by taking into account velocity of the accelerated in electric field electron V, time τ and length λ of free pass we get dependence of the electric strength $E_{пр}$ upon the distance between atoms a along the film's thickness:

$$E_{пр} = \frac{V\sqrt{mE_{зв}}}{qa}, \qquad (1)$$

where m is the mass of electron; q is the electron's charge.

Obviously, that electric strength $E_{пр}$ is inversely proportional to the distance between atoms a.

The distance between atoms can be changed under the action of IMT. Stretching IMT, which operates in the plain of film, decreases the distance between atoms a in normal direction to the surface of film and vice versa due to Puasson's effect .

By transforming Eg. (1) using expression for Puasson's coefficient and Hook's law we shall get desired mathematical model of the dependence of electric strength upon IMT

$$E_{пр} = \frac{V\sqrt{mE_{зв}}}{q(a - \nu a\frac{\sigma}{E})} = \frac{V\sqrt{mE_{зв}}}{qa(1 - \nu\frac{\sigma}{E})}. \qquad (2)$$

Evidently, that IMT influence on electric strength of the M-D-M-structure. Stretching IMT increase $E_{пр}$, and compressive diminish it

III. CONCLUSIONS

1. IMT influence on electric strength of the M-D-M-structure
2. Stretching IMT increase $E_{пр}$, and compressive diminish it

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