Varactor with arbitrary predetermined form of C(V) characteristic and superhigh Cmax/Cmin relation.

The standard varactor's structure presents a semiconductor's film on a heavily doped substrate with opposite type of conductivity. The film and substrate have contacts to apply an external voltage. A main carrier depletion layer is formed in the semiconductor under the certain polarity of a bias voltage. The depletion layer depth (equivalent to an insulating layer in a capacitor) depends on the bias voltage and the doping distribution in a film. The limitations of standard varactors are:

1. It's impossible to realize an arbitrarily predetermined **C(V)** characteristics of varactors because of two reasons:

   a) technology difficulty of forming a doping profile with predetermined impurity distribution in the film,

   b) impossibility of realization some practically important **C(V)** characteristics by means of any real impurity distribution.

2. The minimal value of varactor's capacitance depends on a breakdown voltage.

The standard varactor is equivalent to a capacitor with varying capacitance by changes a distance between plates by means of the bias voltage. To eliminate the limitations of standard varactors a new varactor structure is proposed. In those structure a distance between capacitor's plates and plate's area are changed simultaneously with bias voltage. That principle offers to realize an arbitrary predetermined form of C(V) characteristic easy to manufacture.

Fig.1. shows one of some variants of the proposed varactors. The p+ type substrate has an ohmic contact. The n-type film (with depth **D**) has an ohmic contact formed as a line on perimeter of working region of the film. In a working region of the film (**$0 \le x \le X_{max}$, $0 \le z \le F(x)$**) there is a non uniformly profile of donor **Ni(x,y)** created by ionic doping. The implantation dose is increased from Xmax to 0. Beyond the working region a film is lowly doped and fully depleted by main carriers if bias voltage on a junction is zero. The space charge region (SCR) gradually fills a working region of the film with increasing of back bias voltage. So a neutral region size **H(V)** and an effective capacitor's plate area S are decreased continuously:

$$S = Sk + \int_0^{H(V)} F(x)dx$$

Where ***Sk*** **-** is an ohmic contact area over the SCR. Three parameters (**F(x),D(x),Ni(x,y)**) may be variable for realization of predetermined **C(V)** unlike the standard varactor structure, where **C(V)** depends on profile **Ni(x,y**) only. That fact makes possible to realize different type of C(V) characteristic. *It's very important that a complex technical problem of specified doping profile forming is replaced by simple problem of specified mask coating forming.*

A limitation of this device is a low merit factor because of high neutral region's volume resistance. Such a limitation is eliminated by means of high conductive strips on film's working region surface fabricated along **z** direction with gap past contact line (Fig.2).

Fig.3. shows a calculated form of a film's working region for varactor with a linear **C(V)** characteristic. The varactor is formed by ion phosphorus implantation (energy 200 keV) in a lowly doped n-type Si film (0,6 mkm depth) with linearly decreasing implantation dose along **x** (from 10^{12} to $1.54\ 10^{11}$ ion/cm^2

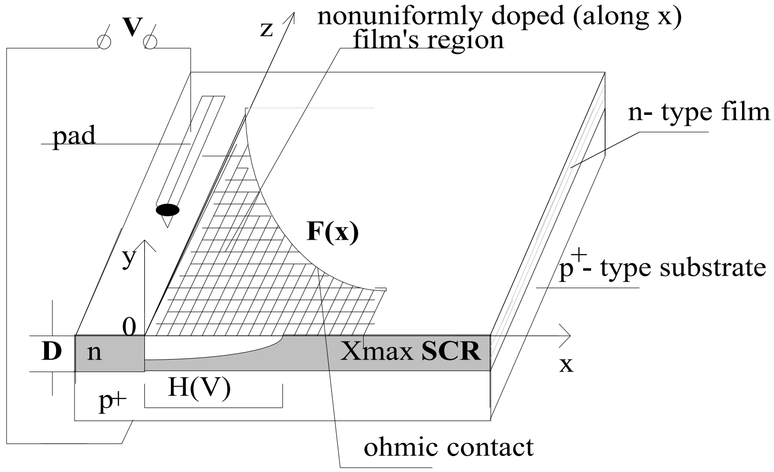

Fig. 1. The MEA varactor

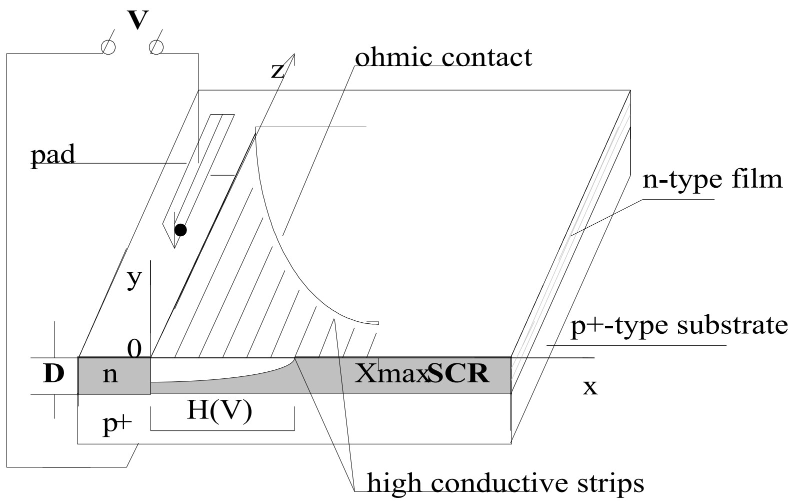

Fig. 2. The MEA varactor with high conductive strips

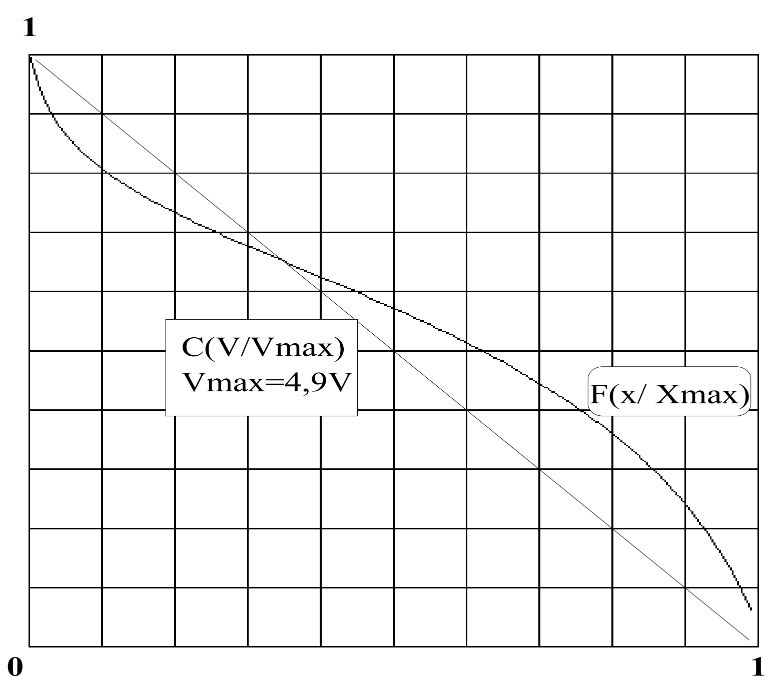

Fig.3. The calculated form of a film's working region for the MEA varactor with lineal C(V) characteristic