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DISTRIBUTION OF POTENTIAL BARRIER HEIGHT LOCAL VALUES AT Al-SiO_2 AND Si-SiO_2 INTERFACES OF THE METAL-OXIDE-SEMICONDUCTOR (MOS) STRUCTURES

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ABSTRACT

Using the photoelectric measurement methods distributions have been determined of the gate-dielectric $E_{BG}(x, y)$ and semiconductor-dielectric $E_{BS}(x, y)$ barrier height values in square gate (1 x 1 mm^2) Al-SiO_2-Si(n^+) structures. Measurements have been made on a series of 26 MOS capacitors with semitransparent gates (t_{Al} = 35 nm), on one silicon wafer. Barrier heights were measured using the modified Powell-Berglund and the modified Fowler methods. Measurement methods were modified in such a way as to allow determination of $E_{BG}(x, y)$ and $E_{BS}(x, y)$ distributions, as described in the text. It has been found that the $E_{BG}(x, y)$ distribution has a characteristic dome-like shape which is identical with the independently determined shape of the effective contact potential difference $\phi_{MS}(x, y)$ distribution. The $E_{BS}(x, y)$ distribution is of a random character and differences between highest and lowest values of E_{BS} for any of the measured capacitors are much smaller than the respective differences in E_{BG} values. These results show that it is the gate-dielectric barrier height distribution $E_{BG}(x, y)$ which causes the dome-like shape of the $\phi_{MS}(x, y)$ distribution, observed for several years in our laboratory. This finding supports our hypothesis that the characteristic $\phi_{MS}(x, y)$ distribution over the gate area of Al-SiO_2-Si structures results from the mechanical stress distribution under the gate electrode.