Ultra-shallow fluorine implantation from r.f. plasma as a method for improvement of electro-physical properties of MIS structures with PECVD gate dielectric layers

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In the present work a comprehensive analysis of changes in electrical characteristics and reliability of MOS (Al/SiO₂/Si) and MIS (Al/SiOₓNᵧ/Si) structures in which gate structure is a layer rich in fluorine, was carried out. Silicon substrate surface prior the formation of MOS and MIS test structures has undergone, different than usually found in the literature, the processes of ultra-shallow ion implantation with CF₄ plasma. For this purpose, the classical PECVD (Plasma Enhanced Chemical Vapor Deposition) and RIE (Reactive Ion Etching), plasma reactors, were used. To perform gate dielectric layer PECVD method was used. Analysis of electrical properties was complemented by spectroscopic measurements (SIMS), which allowed the identification of the causes and consequences of observed changes in electro-physical parameters.

Performed technological experiments and spectroscopic measurements (SIMS) showed that the processes of ultra-shallow ion implantation of fluorine in CF₄ plasma, carried out in conventional plasma reactors (PECVD and RIE), are ideal for surface modification of silicon substrates by introducing into their area of high concentration fluorine.

Despite the different construction of the reactors (different electrode geometry) in which the fluorine implantation processes were carried out, very similar values of fluoride concentration in the passivate layer was obtained. It is worth pointing out also that made by PECVD gate dielectric layer (SiO₂ and SiOₓNᵧ) are a very good barrier to protect the semiconductor area surface before desorption of fluoride, as evidenced by the thermal stability of the concentration of fluorine atoms.

Keywords
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