Publ. Astron. Obs. Belgrade No. 103 (2024), 143 *Poster*
https://doi.org/10.69646/aob103p143

FLUOROCARBON POLYMERIZING PLASMAS ETCHING PROCESSES FOR STRUCTURES OF MICRELECTRONICS

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Abstract. Precision etching of microstructures with minimal levels of introduced contaminants and electrically active defects is a key technology for creating transistor structures for ICs with process nodes below 28 nm. To ensure high accuracy in the transfer of the lithographic pattern and the verticality of the walls, it is necessary to implement an anisotropic etching mode with passivation of the walls. One of the approaches to this problem is the use of fluorocarbon plasma, which, on the one hand, provides a sufficient concentration of atomic fluorine, and on the other hand, effective passivation of the side walls due to the polymerization of fluorocarbon molecular radicals. The reactive ion etching of silicon through the mask of electron was investigated experimentally in ICP plasma with substrate biasing in the SF_6/C_4F_8 feeding mixture for different gas compositions. To understand the kinetics of film formation and etching, concentrations of neutral particles were evaluated using plasma optical emission spectroscopy. Electron temperature and electron density were measured by the Langmuir probe method, see Rudenko, 2007. A high etching selectivity equal to 8 was obtained for the etching process. As a result, the silicon nanowires with critical size of 8 nm on Silicon-On-Insulator wafer were made and investigated. The distribution of lattice displacement defects in surface layer caused by ion bombardment during plasma etching was simulated by Monte Carlo model. Also growth rates of films or etching of surfaces of functional layers from $Ar/CF_4/H_2$ plasma were investigated, see Kuzmenko, 2023. The polymerizing ability is determined by the CF_4/H_2 gas ratio, and Ar allows optimization of physical sputtering. At high CF_4 proportions in the plasma, the deposition rate is determined by the concentration of fluorocarbon radicals in the plasma. Understanding the kinetics of the fluorocarbon film deposition process enables optimization of the cyclic atomic layer etching process. The study was supported by the RSF grant no. 23-29-00771, https://rscf.ru/en/project/23-29-00771/.

References

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