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Realistic and real-time 3D high-aspect-ratio (HAR) etching simulation for the various plasma processes

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With the advancement of the semiconductor device industry, the plasma process is facing the limits of physicochemical fabrication because of unexpected abnormal profile issues. To address the unforeseen problem in the ultra-fine semiconductor process, researchers must understand the relation of the plasma process between the external parameters and the etched profile.

K-SPEED, a realistic and real-time 3D feature profile platform, has been developed by the Korea plasma consortium that can use bulk plasma information related to bulk plasma process parameters [1]. This simulator was composed of a multiple 3D level set, a ballistic transport, and a plasma-surface reaction algorithm with parallelization techniques. For example, the ballistic transport for all plasma species is calculated by the Graphics Processing Units (GPU) with the CUDA library and plasma-surface reaction, and the openMP technique to finish the 3D feature profile simulation in real process time. Also, we developed a plasma-surface reaction set with a steady-state polymer layer to express the realistic surface moving under the fluorocarbon plasma on a carbon-riched passivation layer [2-3]. The 3D contact hole etching profile with the fluorocarbon plasma-surface reaction set is done well with an experimental SEM image.

Additionally, based on the computation algorithms, we have expanded the usage of the 3D feature profile simulator to other plasma processes such as HBr/Cl_2 mixture plasma etching, atomic layer deposition and etching process, and ion sputtering process for metal substrate. The results of 3D feature profiles show the various physicochemical data on the 3D feature profile, such as flux distribution, polymer layer thickness, and etch rate that can help interpret profile shape.

References

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