TF-P064

Process Optimization of PECVD SiO2 Thin Film Using SiH4/O2 Gas Mixture

Tae-min Ha[1], Seungnam Son[1], Jun Yong Lee[2], Sang Jeen Hong[1]

[1]Department of Electronic Engineering, Myongji University, [2]Rainbow Corporation

Plasma enhanced chemical vapor deposition (PECVD) silicon dioxide thin films have many applications in semiconductor manufacturing such as inter-level dielectric and gate dielectric metal oxide semiconductor field effect transistors (MOSFETs). Fundamental chemical reaction for the formation of SiO2 includes SiH4 and O2, but mixture of SiH4 and N2O is preferable because of lower hydrogen concentration in the deposited film [1]. It is also known that binding energy of N-N is higher than that of N-O, so the particle generation by molecular reaction can be reduced by reducing reactive nitrogen during the deposition process. However, nitrous oxide (N2O) gives rise to nitric oxide (NO) on reaction with oxygen atoms, which in turn reacts with ozone. NO became a greenhouse gas which is naturally occurred regulating of stratospheric ozone. In fact, it takes global warming effect about 300 times higher than carbon dioxide (CO2).Industries regard that N2O is inevitable for their device fabrication; however, it is worthwhile to develop a marginable nitrous oxide free process for university lab classes considering educational and environmental purpose. In this paper, we developed environmental friendly and material cost efficient SiO2 deposition process by substituting N2O with O2 targeting university hands-on laboratory course. Experiment was performed by two level statistical design of experiment (DOE) with three process parameters including RF power, susceptor temperature, and oxygen gas flow. Responses of interests to optimize the process were deposition rate, film uniformity, surface roughness, and electrical dielectric property. We observed some power like particle formation on wafer in some experiment, and we postulate that the thermal and electrical energy to dissociate gas molecule was relatively lower than other runs. However, we were able to find a marginable process region with less than 3% uniformity requirement in our process optimization goal. Surface roughness measured by atomic force microscopy (AFM) presented some evidence of the agglomeration of silane related particles, and the result was still satisfactory for the purpose of this research. This newly developed SiO2 deposition process is currently under verification with repeated experimental run on 4 inches wafer, and it will be adopted to Semiconductor Material and Process course offered in the Department of Electronic Engineering at Myongji University from spring semester in 2012.

Reference

1. H. D. Puppo, J. Desmaison, and L. Peccoud, “A Comparative Study of O2/SiH4 and N2O/SiH4 Mixtures for SiO2 Deposition in a Microwave Afterglow,” J. Phys. IV France, vol. 03, no. C3, pp. 241-246, 1993.

Keywords: Process optimization, SiH4/O2