The Role of Discharge in Plasma Assisted Atomic Layer Deposition Technique

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Due to the continuous minimized size in the microelectronics industry andthe increasing relevance of ultra-thin films in flexible electronics, atomiclayer deposition (ALD) technique has rapidly gained popularity in recent years.Especially plasam assisted ALD (PA-ALD) technique, in which the plasma is generatedduring one step of the cyclic deposition process, the excited species used toreact with the absorbed precursor allow for more flexibility in processingconditions, for wider selecting precursors, and for a wider range of materialproperties compared with the conventional thermally driven ALD (T-ALD)technique. In this work the species in plasma and their role in the surfacechemistry are addressed. We present results based on the inductitive couplelyplasma (ICP) and dielectric barrier discharge (DBD) sources assisted ALDtechnique. The species in PA-ALD are diagonized by optical emmissionspectroscopy (OES), and reactive paths on the interface are assumed then aftercombining OES with the quartz crystal microbalance (QCM) results. With Cu (amd) as copperprecursor the metal copper film is deposited at 50^0C temperature conditionwhen the radio frequency input power is 80 W. A high purity, conformal,continuous, smooth copper film could be obtained inside the silicon trench withthe aspect ratio of 10:1, and deposition rate of this process was 0.071nm/cycle. In DBD plasma source we deposit Al_2O_3 on polylaticacid (PLA) web as a barrier layer of the gas and moisture. Itis obtained that the growth rate of Al_2O_3 in DBD PA-ALDis as quick as 0.12 nm/cycle. After coated ~40 nm Al_2O_3,the water vapor transmission rate (WVTR) of PLA is reduced by two orders ofmagnitude. Additionally, it is noticed that the tension strength of the coated filmis improved slightly, whereas the light transmission rate are decreased along withAl_2O_3 thickness. The degradation test shows that Al_2O_3coating almost does not affect the self-degradation rate of PLA film.

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