N.CHEUNG,Sp 2008

EEC243: ADVANCED IC PROCESSING AND LAYOUT

Homework Assignment # 9 (Due April 30 , Wed)

Reading Assignment :
PDG Chapter 10
PDG Chap 11 [You can skip sections beyond 11.4)
Lecture Notes

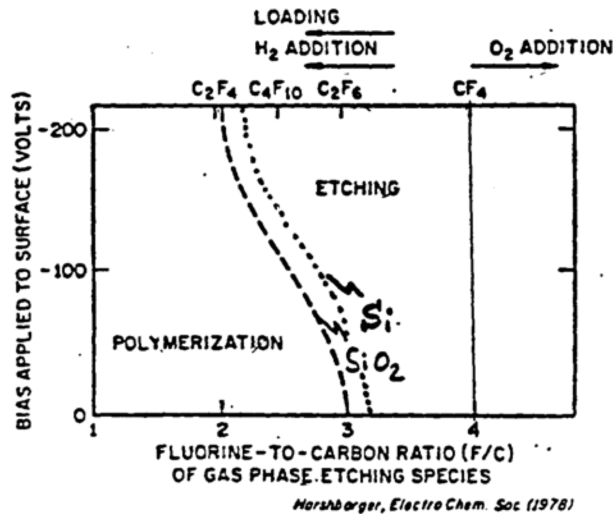
Problem 1 Plasma Processing with RF bias

(a) Consider a parallel-plate sputtering chamber. One electrode has an electrically insulating sputtering target with a thickness of 2.5mm which has a target capacitance of ~ 1pF/cm2. If the ion current density is 1 mA/cm2 with a **DC** applied bias of -1000V, calculate the time required to charge the target capacitance.
[Hint: C = Q/V]

(b) The calculated time in part (a) represents a characteristic time for which the target thickness takes up most of the applied bias potential drop [i.e., little voltage drop across the plasma sheath]. This voltage dividing problem can be overcome by we using an RF bias higher than a certain frequency because the ion surface charges can be neutralized by electrons during the negative cycles. Estimate the minimum applied RF frequency required from answer in part (a).

Problem 2 Fluorine-to-Carbon Ratio Concept for RIE

The Fluorine-to-Carbon Ratio Concept has been used to explain the RIE behavior of Si and SiO_2 by



fluorocarbons .

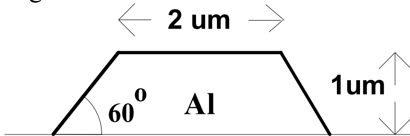
Explain how:
(i) Larger loading decreases Si etching rates.
(ii) The polymerization boundary for SiO_2occurs at a lower F/C ratio than Si.
(iii) Substrate bias affects SiO_2/Si selectivity.

Problem 3 RIE of Al-Cu

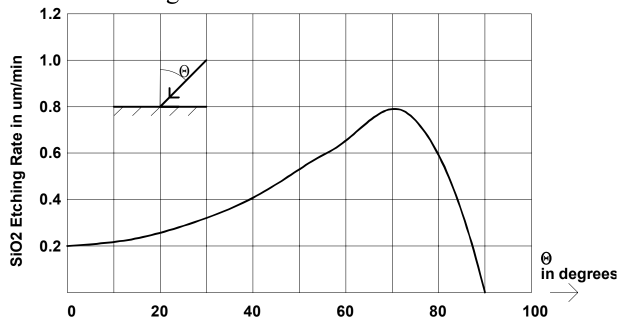
In RIE of Al-Cu alloy with Cl-based etchants, Al Cl_3 and CuCl are formed. CuCl has very low vapor pressure and is primarily removed by physical sputtering. Suppose we use a parallel plate RIE reactor : Will you increase or decrease the following processing parameters to facilitate a faster etching rate.
Explain with several sentences or sketches.

(i) RF power
(ii) RF frequency
(iii) Wafer temperature
(iv) Gas pressure

Problem 4 Simultaneous Etching and Deposition
During sputtering deposition of thin films on a Si substrate, we can have simultaneous deposition and etching of the thin film if a negative voltage is applied to the substrate. the etching of the deposited thin film is due to ion bombardment of the positive ions from the sputtering plasma. Suppose we would like to sputter deposit a layer of SiO_2 on patterned Al lines and the cross-section of the 1 μm-thick Al line has a slope angle of 60°.



For a certain substrate bias voltage, the etching rate of the deposited SiO_2 is found to be a function of the ion incident angle θ to the normal of the surface:



We would like to keep track of the wafer surface topography. Let us assume that the deposition rate is independent of θ and the Al and Si substrate are not etched by the ion bombardment.
(a) With a SiO_2 deposition rate of 1 μm/ minute, sketch the cross-sections of the Al line and SiO_2after (i) 0.5 minute and (ii) 2 minutes.
(b) With a SiO_2 deposition rate of 0.5 μm/ minute, sketch the cross-sections of the Al line and SiO_2 after (i) 1 minute , (ii) 2 minutes and (iii) 6 minutes.
(c) With a SiO_2 deposition rate of 0.1 μm/ minute, sketch the cross-sections of the Al line and SiO_2 after (i) 1 minute , (ii) 2 minutes and (iii) 6 minutes.
(d) Suggest a process sequence to accomplish the following planarized structure using the substrate bias method.