Exam #2 – EE486 Name_____

Spring 2016

There are 5 problems on 4 pages, plus a page of tables/plots. Show all your work. Use back of page if needed.

1. Phosphorus is implanted at an energy of 30keV and dose of $2x10^{14}$ cm^{-2} into Si capped with 10nm of Si_3N_4. Assume that the range statistics are the same in the nitride as in silicon. The implant is annealed at 1000°C.

   (a) Using Gaussian range statistics, calculate the expected range and the dose of implanted P in the Si. (10)

   (b) Assuming a +1.5 model (like +1 model, but multiply by 1.5), if there was an lightly-doped boron buried layer located below the implant, how long an anneal under equilibrium conditions would be required to have the same profile broadening as that due to the implant damage (TED)? (20)

2. An oxide is grown in steam (H_2O) at 1000°C for 2 h on a <111> wafer with an existing oxide. If the initial oxide thickness is 200nm, what will be the final oxide thickness? (20)

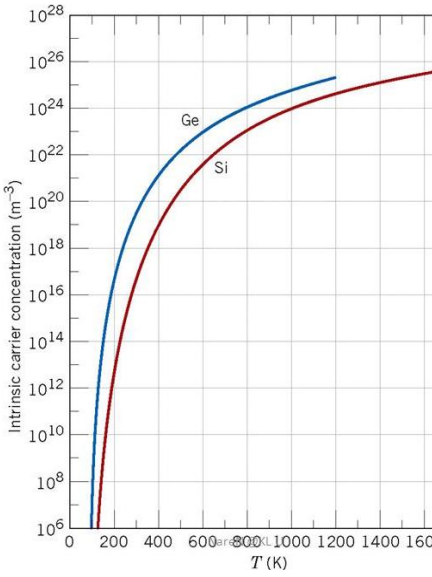
3. If an initial 200nm oxide on a <100> wafer is further oxidized in pure O_2 at 1000^{o}C, what would be the interstitial supersaturation near the beginning of the growth process and the resulting diffusion enhancement factor (D/D*) for As? (20)

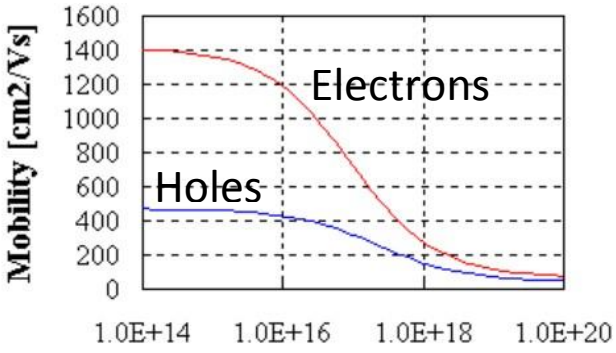
4. Sketch the deposition rate versus temperature for an LPCVD polysilicon deposition process with SiH_2Cl_2/H_2 source gasses. If the pressure is dropped by a factor of 2, but the SiH_2Cl_2 partial pressure is kept the same, what will happen to the deposition rate (increase, decrease, no change) if the process is (a) reaction limited and (b) diffusion limited. Briefly explain answer in each case. (18)

5. In an evaporation chamber, wafers are attached to a flat wafer holder parallel to and 20 cm away from the small area source. If the angular distribution of the source is ideal (n=1), what would be the ratio of deposition rates on a flat wafer surface between the center of the wafer holder (directly opposite source) and 10 cm away from the center. (12)

	Si	B	In	As	Sb	P
$D^0.0$	560	0.05	0.6	0.011	0.214	3.85
$D^0.E$	4.76	3.5	3.5	3.44	3.65	3.66
$D^+.0$		0.95	0.6			
$D^+.E$		3.5	3.5			
$D^-.0$				31.0	15.0	4.44
$D^-.E$				4.15	4.08	4.0
$D^=.0$						44.2
$D^=.E$						4.37

	f_I	f_V
Silicon	0.6	0.4
Boron	1.0	0
Phosphorus	0.98	0.02
Arsenic	0.4	0.6
Antimony	0.02	0.98





<111> Si	B	B/A
Dry O_2	$C_1 = 7.72 \times 10^2$ μ^2 hr^{-1} $E_1 = 1.23$ eV	$C_2 = 6.23 \times 10^6$ μ hr^{-1} $E_2 = 2.0$ eV
H_2O	$C_1 = 3.86 \times 10^2$ μ^2 hr^{-1} $E_1 = 0.78$ eV	$C_2 = 1.63 \times 10^8$ μ hr^{-1} $E_2 = 2.05$ eV