Question #73788, Chemistry / Physical Chemistry / Completed

To make a thin film of SiO2 in a vacuum chamber, you start with 1.00 mm x 1.00 mm piece of Mo metal as the substrate to build your film on. The first step of the process is to put down a 0.010 mm thick film of Si atoms onto the piece of Mo metal. This Si film has a density of 8.41 x 10^22 atoms/mL. The next step is to oxidize the film with O2 gas. You need two Oxygen atoms for every one silicon atom you have in the film. How many O atoms do you need to make the SiO2 film?

b) This process in only 20. % efficient (meaning 1 atom in 5 react). What is the minimum number of O atoms you need to make the SiO2 film?

c) If there are 1.4 x 10^22 O2 molecules/mL of gas, how many L do you need?

Solution

$Si + O_2 = SiO_2$

The volume of the Si layer: V = 1 mm^2 x 0.010 mm = 0.010 mm^3 or 1e-5 mL.

The number of atoms of Si: 1e-5 mL x 8.41 x 10^22 atoms/mL = 8.41e+17 atoms.

The number of O atoms (theory): 8.41e+17 · 2 = 1.682e+18.

b)

1.682e+18 atoms · 100% / 20% = 8.41e+18 atoms.

c)

8.41e+18 atoms / 1.4 x 10^22 O2 molecules/mL = 6.007e-4 mL

Answer: 1.682e+18; 8.41e+18; 6.007e-4 mL.