EECS 243 – Advanced IC Processing and Layout

Fall 2000	**Office Hours**	**Prof. A. R. Neureuther,**
Tu, Th 3:30-5	**M, Tu,Th, (F) 11am**	**510 Cory Hall, 2-4590**
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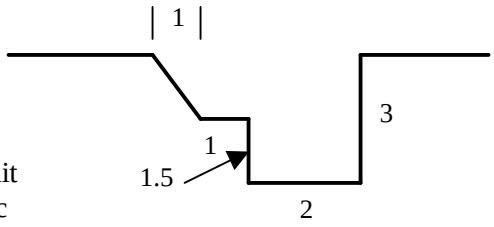
Homework Assignment # 7, Due Tu, Oct 24th, 00

Revised 10/19/00

Reading for Week #7: PDG Chapter 10; ARNL3-4 pp. 55-105, skip pp. 71-75. The midterm exam will be Thursday, October 26. It will be open book, open notes, and paper will be provided. Bring your calculator. A topical review will be made in class on Thursday, October 19th and the scope of the midterm will be posted on the web.

7.1 Basic deposition and etch profile time-evolution models

Sketch the time-evolution of the intial profile shown on the right as requested below. Thickness quoted are for horizontal surfaces.



a) Isotropic deposition of 1.0 unit of material. Show shocks and fans.
b) Then follow step 1 with isotropic etching of 1.0 unit of material. (Under what circumstances is isotropic etching not an undo of isotropic deposition?)
c) On a fresh initial profile directional deposition of 1.0 unit of material from an angle of slightly less than 45 from normal off center to the left.

7.2 Selectivity/anisotropy and device structure issues.

A 300 nm thick polysilicon gate layer crosses an oxide on an active area and climbs a steep 60^o ramp up the bird's beak to the field at a height of 400 nm from the gate oxide. The poly is to be etched to form the gate structure. The stringer must be removed and the trade-off in damage to an underlying oxide (due to low selectivity) and underetching of the gate (due to poor anisotropy) are to be characterized in a design graph. Use the etch rate ratio data and degree of anisotropy from Figure 4.5 ARNL3-4 pp.88 in the following. (See pp. 89 for an example.)

a) Determine the required over-etch factor from the geometry.
b) Plot the depth of oxide removed versus anisotropy ratio $A_R = [A/(A+I)]$ where A is the anisotropic etch rate and I is the isotropic etch rate.
c) Plot the undercut at the top of the gate versus A_R.
d) Repeat b) and c) assuming that the first 300 nm is etched purely anisotropically.

7.3 Reverse Engineering of Etched Profiles

Use the basic relationships between etch rate ratios and planar wall facets to reverse engineer the relative etch rates in the following. (Watch out the horizontal and vertical scales differ.)

a) For Figure 10-27 a) b) and c), pp. 660 PDG00 determine the isotropic etch rate relative to the total etch rate of the substrate. Estimate the theoretical wall angle and measure it.
b) For Figure 10-28 a) and b), pp. 661 PDG00 determine the normal incident, and peak etch rate of the mask material relative to the substrate. Use two of these values and the angle of the mask to estimate and compare the theoretically expected sidewall angle in the substrate material to that shown in Figure b).