ring pattern exposure in HSQ: a quality examination 1/19/11 Devin K. Brown

Motivation

photonic structures use curved waveguides and rings

- edge smoothness is important for achieving high Q factor
- one fabrication approach is to use HSQ as a resist and etch the pattern in the silicon layer of an SOI wafer
- it is important for the pattern in HSQ to have smooth edges
- it is known that HSQ is a very sensitive resist to subfield boundaries

this presentation studies

•the ring pattern quality in HSQ – particularly subfield boundaries and placement

•using

- •1) different CAD preparation approaches and
- •2) increasing dose

Example of Subfield boundary defects





Shot Shape Display



these defects occur even with dense shot pitch of 2 nm

Experiment

- use JBXFILER and Layout BEAMER with different conversion settings
- vary dose



file = hsqcircle500.dxf. 5 um diameter donut with 0.25 um width. Placed at center of 500 um field, and four corners.

converted to GDSII using LinkCAD using 128 segments / 360 deg. This GDSII file was imported both to JBXFILER and Layout BEAMER. The dxf file was not imported to LB due to unreliable conversions of that format.

conversion 1

hsqcircle500-001.v30, JBXFILER, output step = 1000 (1 nm grid)



conversion 2

hsqcircle500-002.v30, JBXFILER output step = 500 (2 nm grid)



conversion 3

hsqcircleLB1.v30, Layout BEAMER, fracture mode 1, (fracture mode 2 not much different), center to field



conversion 4

hsqcircleLB2.v30, Layout BEAMER, shot pitch fracturing, pattern units = 1 nm, shot pitch = 2 nm, fracture mode 1, center to field



conversion 5

single3.v30, created by Ming Lu, Brookhaven National Lab output step = 1000 (1 nm grid)



Ming's pattern has primitives exposed in a clockwise progressive order. (JBXFILER and Layout BEAMER primitives are exposed in random order.) The first primitive is at 3 o'clock.

conversion 6

single3.v30, created by Ming Lu, Brookhaven National Lab output step = 500 (2 nm grid)



Process Flow

- <u>substrate:</u>
 - silicon piece
- <u>spin coat:</u>
 - 6% HSQ
 - 2500 rpm, 1250 rpm/sec, 60 sec
 - hot plate bake 80 C, 4 min
 - thickness = 137 nm
- <u>expose</u>
 - 100 kV, 2 nA, shot pitch = 2 nm
 - dose = 1500, 3000, 5000, 7000, 10000 uC/cm2
- <u>develop</u>
 - 25% TMAH, 30 sec immersion
 - 1 min 30 sec, DI water rinse

SEM inspection

 so far only center of field location has been examined for comparison



Dose = 1500 uC/cm2

conversion 5

conversion 6















Dose = 7000 uC/cm2



