Waveguide fabrication with the Heidelberg MLA150 Maskless Aligner

Objective:

In order to make the lowest loss waveguides, we need to find a combination of dose/defocus and reflow time/temperature that gives us the best resolution and the lowest line edge roughness and line width roughness. This is done in two steps, first with software analysis of the optical characterization, we can find the dose defocus that gives us the best resolution in terms of ridges and trenches. Next, we reflow dies with PR ring structures on them. With software analysis of the SEM characterization, we can calculate how the width of rings and LER of rings change with time temperature. A reflow that reduces LER or keeps LER same while changing width or rings is useful for SNF fabrication. Finally, the best reflow time/temperature and best dose/defocus is etched and the best dose/defocus with no reflow is etched. These rings are characterized with AFM, to show how sidewall slope is affected by etching, and if width change of PR corresponds to width change of etch.

Process Flow:

Step No.	SNF/ SNSF Tool ID	Process Step
1	wbclean-res-piranha	Standard Piranha clean
2	i) thermco1 ii) thermconitride	Waveguide material stack growth (oxide growth: 280 microns followed by nitride growth: 450nm) * This step is skipped for dose/ defocus matrix of PR on Silicon.
3	YES oven	Wafer singe and prime
4	svgcoat	PR coat: 1 micron of Shipley 3612 w/o vapor prime, with 2mm EBR
5	Heidelberg	Expose desired pattern on wafer. i) Mask Layout #1: Dose/ Defocus matrix ii) Mask Layout #2: Time/ Temperature Reflow matrix using optimised dose/defocus from (i) for waveguide material stack
6	svgdev	Post exposure bake: 1 min at 110℃ Develop pattern Post develop bake: 1 min at 110℃
7	Optical microscope	i) Image ridge/ trench arrays for dose/ defocus matrix. ii) Image analysis to obtain best dose/ defocus for given substrate.
8	LaserCutter	Laser back scribing of Mask Layout #2 wafer to yield dies
9	hotplate	Reflow individual dies at different time and temperature conditions.
10	Nova SEM	i) Sputter coat with ii)Image PR rings of different widths on each time/ temperature die iii) Image analysis to find LER and LWR for each set of parameters in (i) to obtain an optimum time/ temperature value.
11	AMT-etcher	Using Recipe #4 etch waveguides after reflowing at optimum time/ temperature value
12	gasonic	PR stripping on a carrier pocket wafer using Recipe #013
13	XE-70	AFM step profile of waveguide fabricated with/ without reflow