Fabrication optimization to enhance micro-resonator yield

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FABRICATION OPTIMIZATION TO ENHANCE MICRO-RESONATOR YIELD

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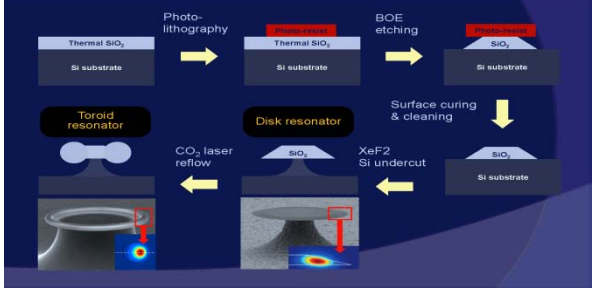
2 Applications that will benefit

- Cavity QED
  - Q and V are key figures of merit.
    - ➔ Q is very sensitive to side wall roughness and structure symmetry
- Cascaded higher-order optical resonator
  - Yield of n^{th} order resonator ≤ (Yield of single resonator)^n
- Large and complex structures based on micro disk and toroid

3 General Fabrication procedure

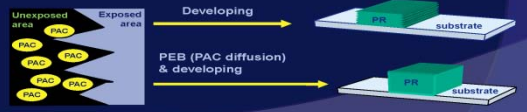


4 Approach - Increasing fabrication yield

- Optimization of fabrication process
  - Increasing surface uniformity by sacrificing dimension definition
  - Non-contact UV exposure by stepper
    - Macro-scale structure uniformity and fabrication yield
  - PEB (post exposure bake) and hard-bake (reflow)
    - Surface roughness
  - BOE (buffered oxide etcher) applying time control
    - Surface roughness and discontinuity on side wall

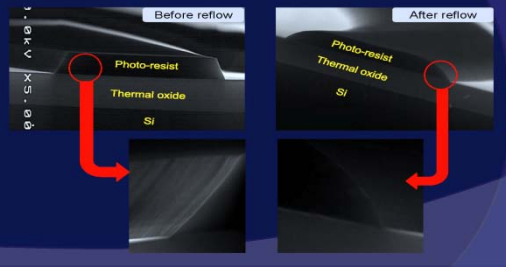
5 Non-contact exposure and PEB

- Non-contact UV exposure by KNI stepper
  - GCA-6300 DSW stepper
  - 365 nm exposure wavelength
  - 0.5 μm resolution, 10mm x 10mm field size
  - Non-contact between mask and wafer
    - ➔ increasing uniformity and quality ➔ increasing fabrication yield
- Post exposure bake (PEB)



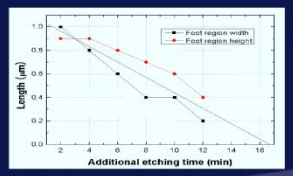
6 Decreasing side wall roughness

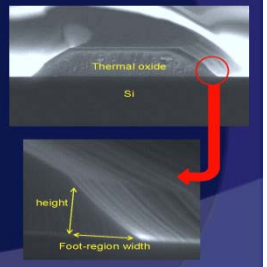
- Photo-resist reflow



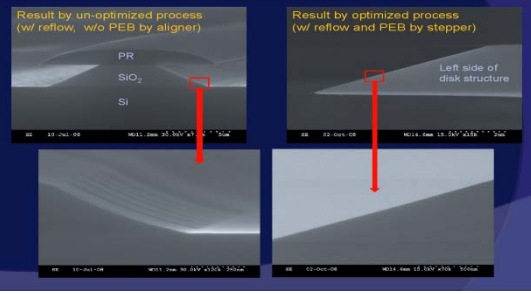
7 Elimination of discontinuity on side wall

- Foot-region on side wall
  - Increasing additional etching time
    - ➔ decreasing foot-region size





8 Result of optimized fabrication



9 Q-Measurement Results

- Q distribution of disks groups fabricated by different conditions
  - More than 15 disks were tested to estimate Q distribution for each fabrication condition.

Exposure method	Bake	Average Q
Aligner (contact)	Reflow	0.8 M
Aligner (contact)	Reflow & PEB	3 M
Stepper (non-contact)	Reflow & PEB	17 M