DEVELOPING ROBUST QUALITY SYSTEMS FOR CMP SOLID CONSUMABLES:

PART 1. RETAINER RINGS.

Alex Tregub, Ashwani Rawat

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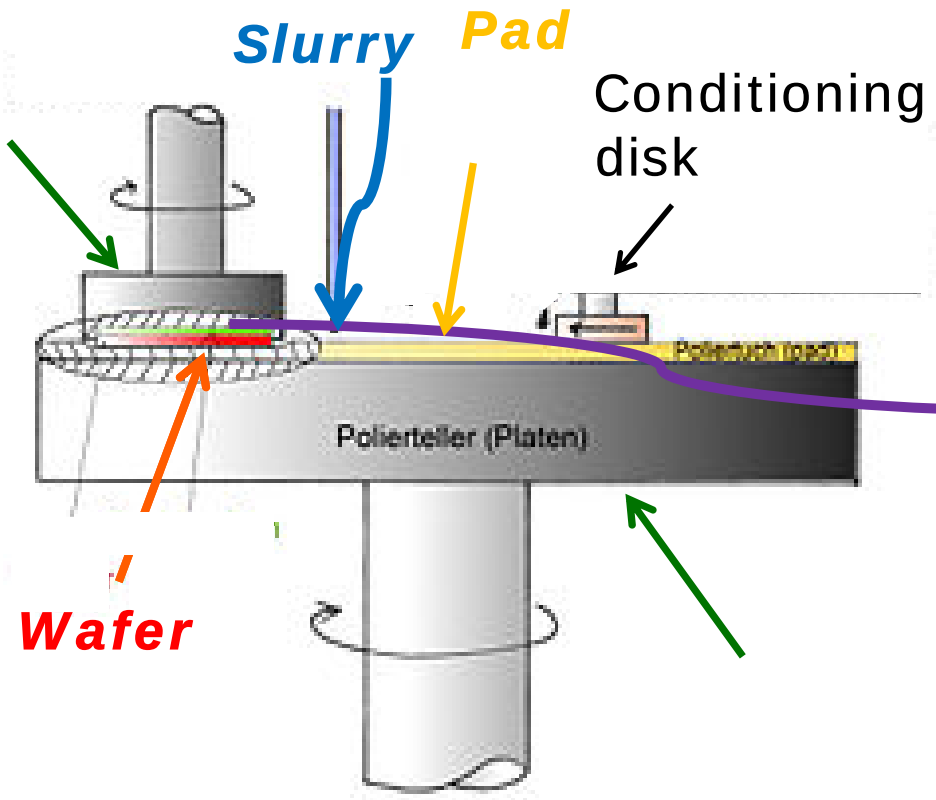
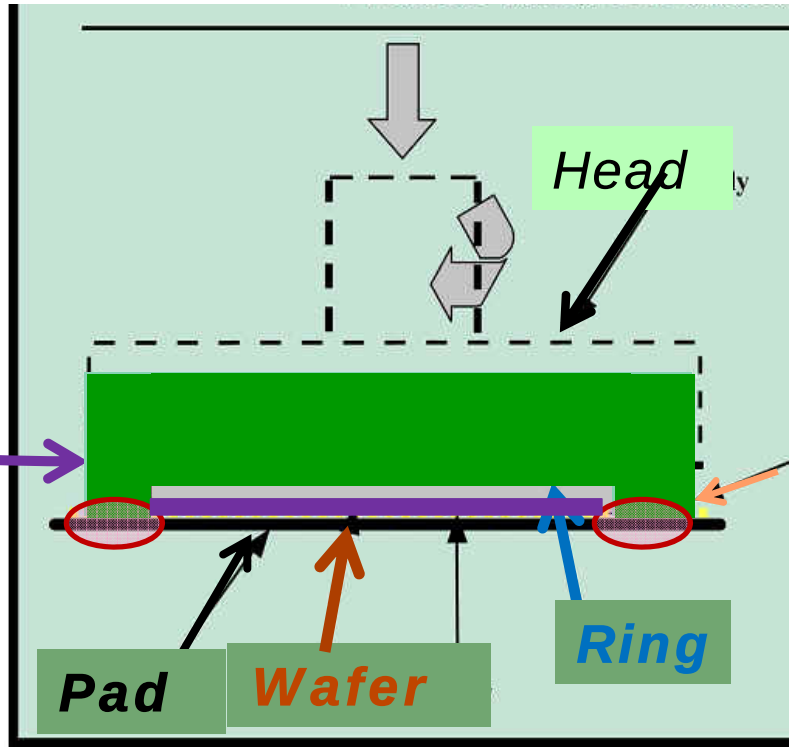
Problem Statement

- **ISSUE:**
  - Few quality monitors for CMP retainer rings, a “non critical” CMP part
- **CONSEQUENCES**:
  - Quality issues during chip manufacturing; quality control gaps at suppliers; ring material may not be optimized
- **SOLUTIONS**:
  - Develop capable quality monitors, metrologies for Retainer Rings for CMP industry

CMP Retainer Ring explained

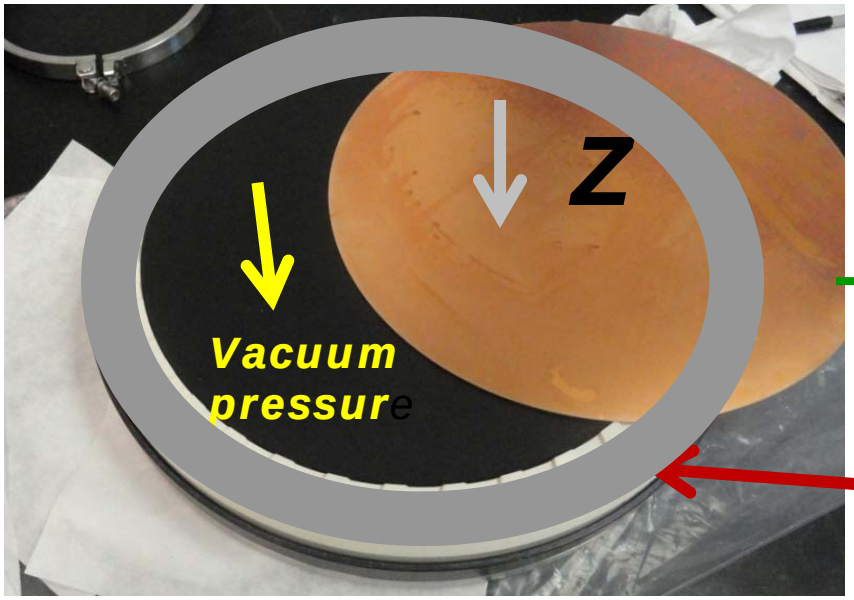
CMP used for wafer palanarization with the combination of chemistry and mechanics

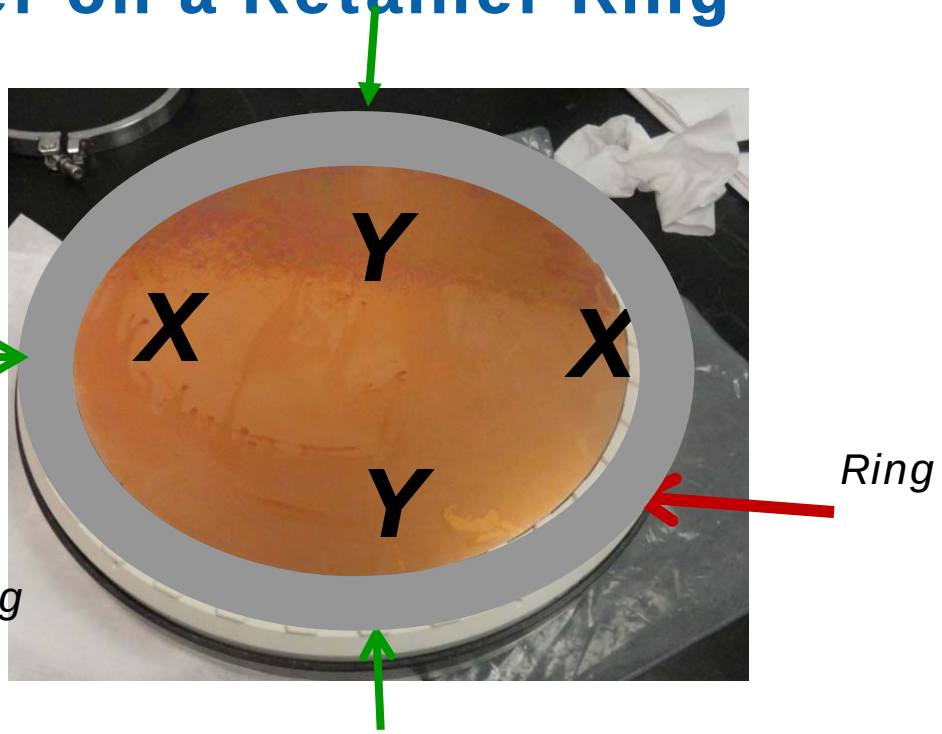




Retainer rings used to be considered “non critical” CMP part

Maintaining the Wafer on a Retainer Ring





Wafer before maintaining inside the retainer ring
Membrane (black) is shown
Wafer is kept in Z direction from "falling off" via applied vacuum

Wafer maintained inside the retainer ring
Retainer ring keeps wafer in X/Y direction to avoid wafer sliding off

CMP Trends and Advanced Technology Nodes

- Increased sensitivity of the wafer defects to consumable contribution due to:
  - transistor scaling down
- Increased consumption of CMP consumables due to:
  - larger number of layers in chip architecture
  - multiple polish of the same layer to decrease litho pitches
  - new layers with unusual properties

Retainer Rings Metrology Issues

- CoA parameters for retainer rings are limited
- CoA parameters not always correlate to retainer rings performance in chip manufacturing
- Parameters not measured and reported consistently and universally across CMP industry
- **Result**:
  - CoA parameters do not always correlate to retainer rings performance in chip manufacturing
- **Consequences**:
  - Quality issues in the advanced chip manufacturing nodes

Identifying predictive quality parameters

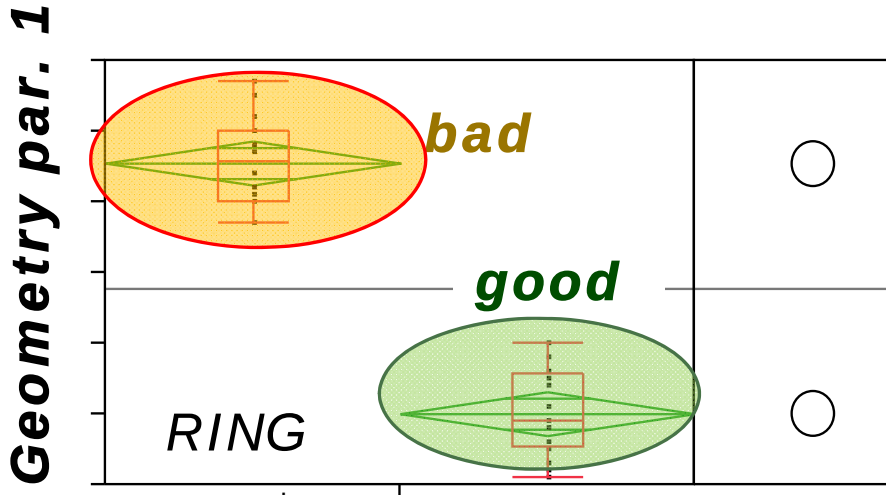
Parameter	Differentiation	Comment
Geometry parameter 1	Good > Bad	Easy to measure
Geometry parameter 2	Bad > Good	Easy to measure
Geometry parameter 3	Bad > Good	Easy to measure
Geometry parameter 4	Good ~ Bad	No correlation
Geometry parameter 5	Good ~ Bad	No correlation
Geometry parameter 6	Good > Bad	Difficult to measure
Geometry parameter 7	Bad > Good	Difficult to measure
Geometry parameter 8	Bad > Good	Difficult to measure
Geometry parameter 9	Good > Bad	Difficult to measure
Geometry parameter 1	Good > Bad	Difficult to measure

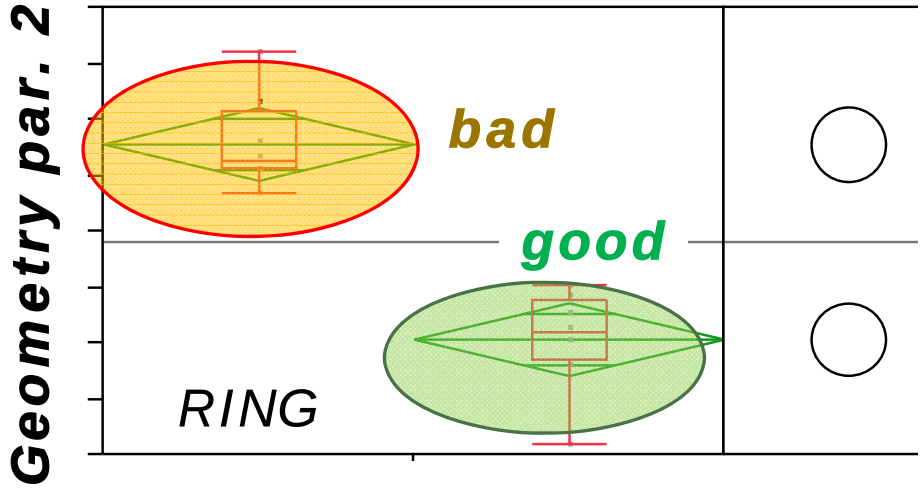
10 new geometry parameters introduced

3 correlated to performance, easy to measure

Example of Predictive Parameters

- Issue: certain batches of “bad” rings cause increased wafer defectivity
- CoA parameters did not show any difference between “bad” and “ good” batches
- We have developed & validated 2 predictive parameters





New quality parameters showed difference between “good” and “bad” rings

Summary: Requirements for Quality Control Monitors

- Quality monitors need to be correlated to chip manufacturing performance
- Quality monitors should help identifying the root cause of the quality issues in chip manufacturing
- Quality monitors should be used for process control at retainer rings manufacturing

Challenges

- Developing quality parameters with reliable correlation to performance is crucial for quality management and consumable optimization
- New technology trends increase CMP consumables contribution to overall cost and defectivity
- Consumables control must keep pace with increased process sensitivity