# Manufacturing Issues with Current CMP Ring Technology: Tolerance

- Poor consistency of manufactured dimensional tolerances
  - Change in tolerance over time (creep)
  - Notch wear on inner ring diameter
- Dimensional inconsistencies lead to decreased yields and lower plant efficiency
  - Increased wafer breakage (slippage)
  - Degraded process consistency (WIWNU)
  - Increased cost
    - Non-optimized tool utilization
    - Increased carrier rebuilds
    - Test wafer usage

# Manufacturing Issues with Current CMP Ring Technology: Wear

- Poor choice of materials of construction
  - Sub-optimal wear characteristics per application
    - Variability in wear rate for dielectric, tungsten and copper
  - Variability in raw material source
    - Results in large variation in expected ring lifetime
- Material choice key for low cost of ownership (CoO)
  - Frequent and expensive ring changes
    - Cost of ring
    - Tool downtime to for ring installation
    - High CoO
  - Poor defectivity due to plastic extrusion variations
    - Voids
    - Non-homogeneous materials (density)
    - Variable wear and shedding

# Demonstrated Commercial Successes

- Eliminated Speedfam CMP V ring wafer breakage issue for tungsten CMP
- Reduced edge wear on Ebara platform by 8X over OEM ring
- Improved CoO of Strasbaugh rings by 66% over previous second source supplier
- Delivered a 2.5X improvement in ring life on IPEC 472 platform over OEM solution

# Semplastics' World-Class Plastics Capability

- ULTRAFLAT™ -Semplastics' proprietary technology
  - Holds flatness and parallelism of a specified dimension in a mounted and fixed position
    - 10 microns maximum for 200mm applications
    - 15 microns maximum for 300mm applications
  - All CMP rings are manufactured with ULTRAFLAT™ technology
- Superior plastics knowledge allows for optimizing both the machining and wear properties
  - Different plastics need variations in machining to achieve ultra-precision metrics
    - Semplastics has the experience needed to machine numerous types of plastics to these specifications
  - Wear properties are controlled by the choice of materials
    - Different CMP processes have variable wear rates on ring plastic
    - Semplastics can optimize the material choice to reduce wear and CoO
- Superior quality control for ring manufacture
  - Identify and measure each ring
    - Ring I.D., thickness, parallelism, flatness all QC controlled and traceable



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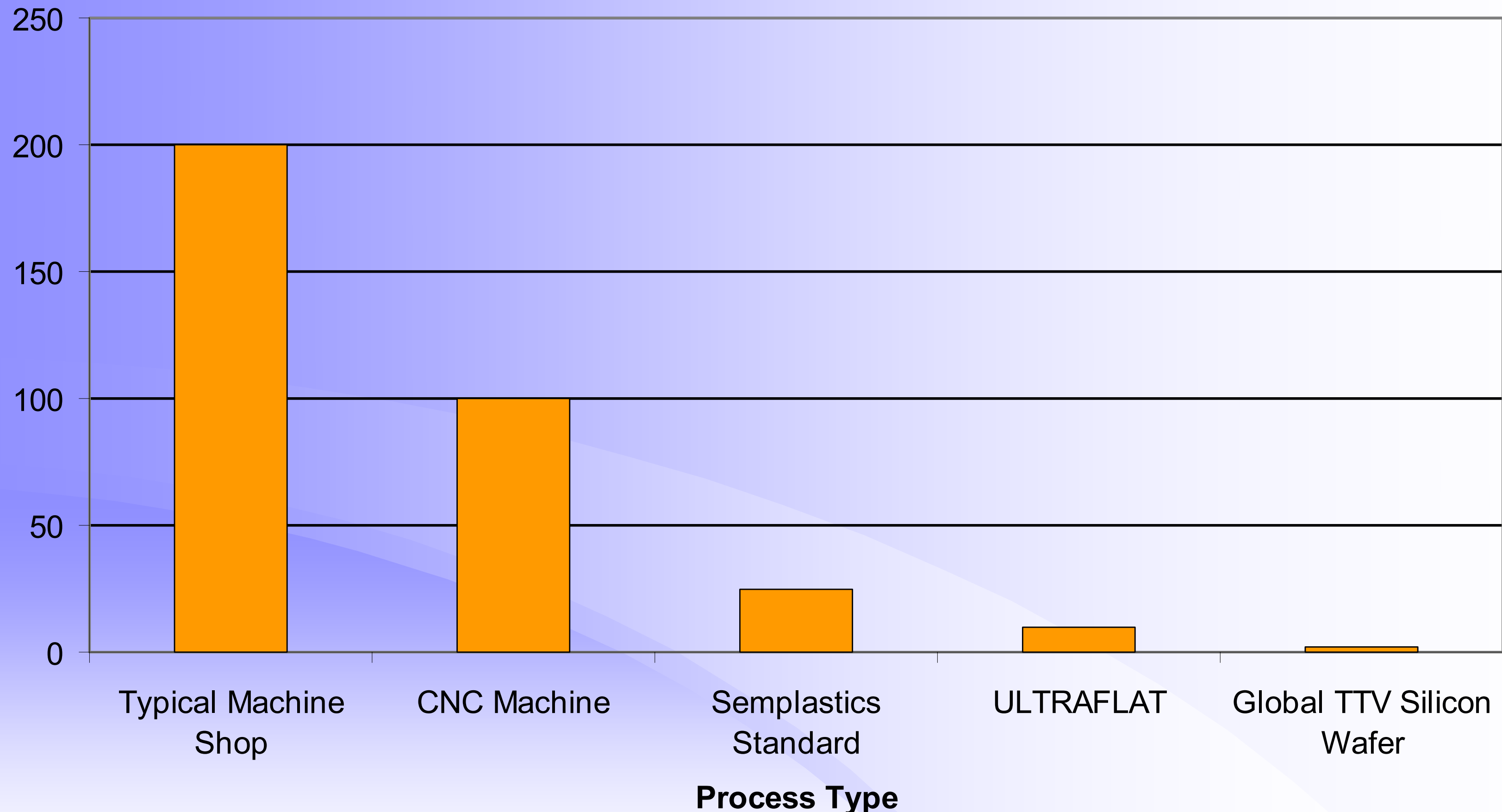
# Example of ULTRAFLAT™ Ultra-Precision Plastic Fabrication



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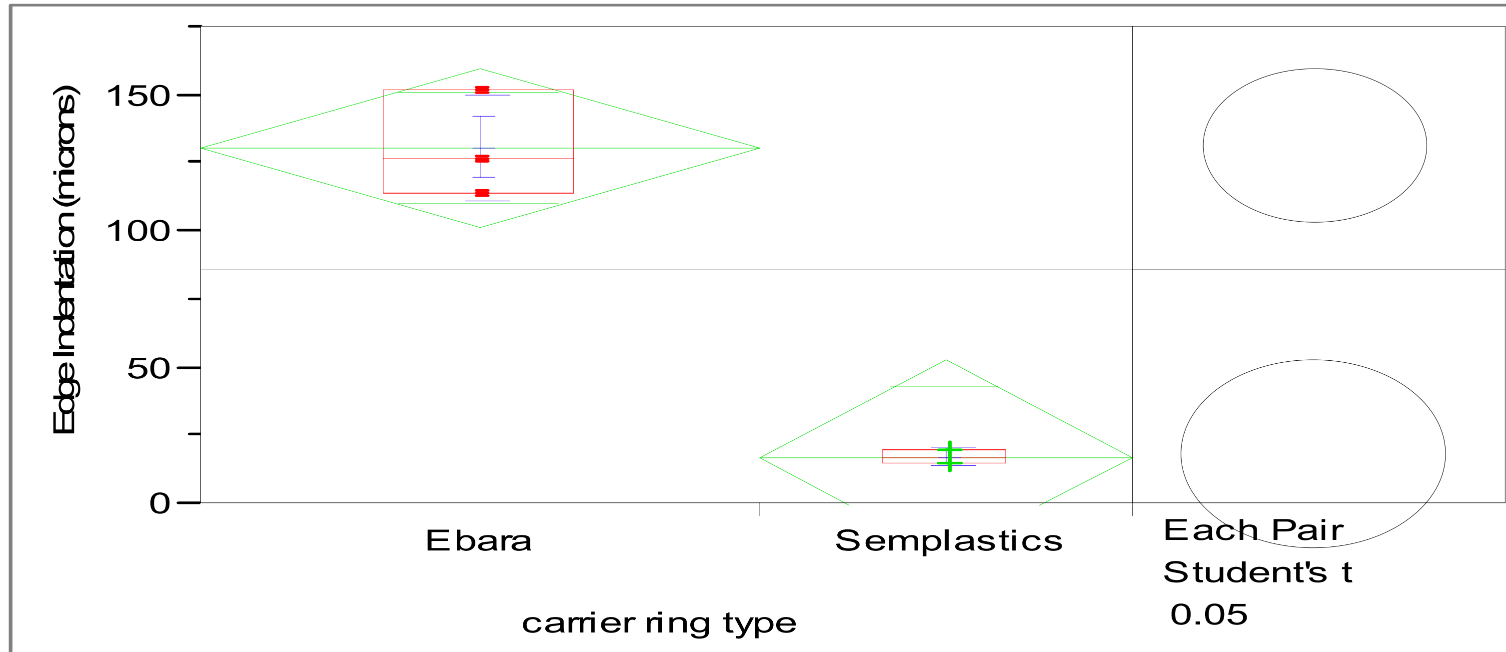
# Ebara Carrier Ring Inner Edge Indentation Comparison

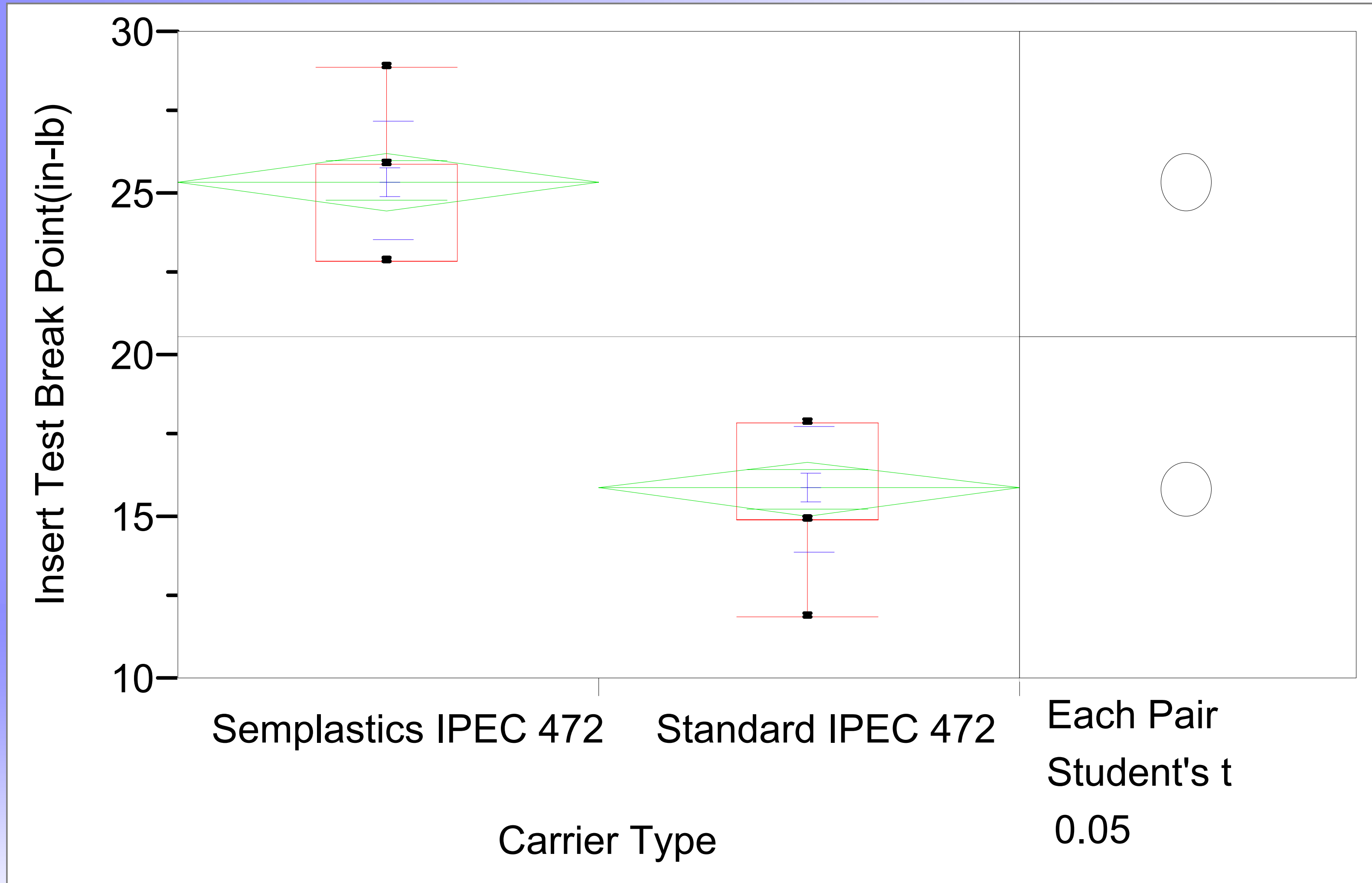
Oneway Analysis of Edge Indentation (microns) By carrier ring typ




Means and Std Deviations

| Level | Number | Mean | Std Dev | Std Err Mean | Lower 95% | Upper 95% |
|---|---|---|---|---|---|---|
| Ebara | 3 | 131.000 | 19.3132 | 11.150 | 83.02 | 178.98 |
| Semplastics | 2 | 17.500 | 3.5355 | 2.500 | -14.27 | 49.27 |

# SF-IPEC Ring Insert Improvement



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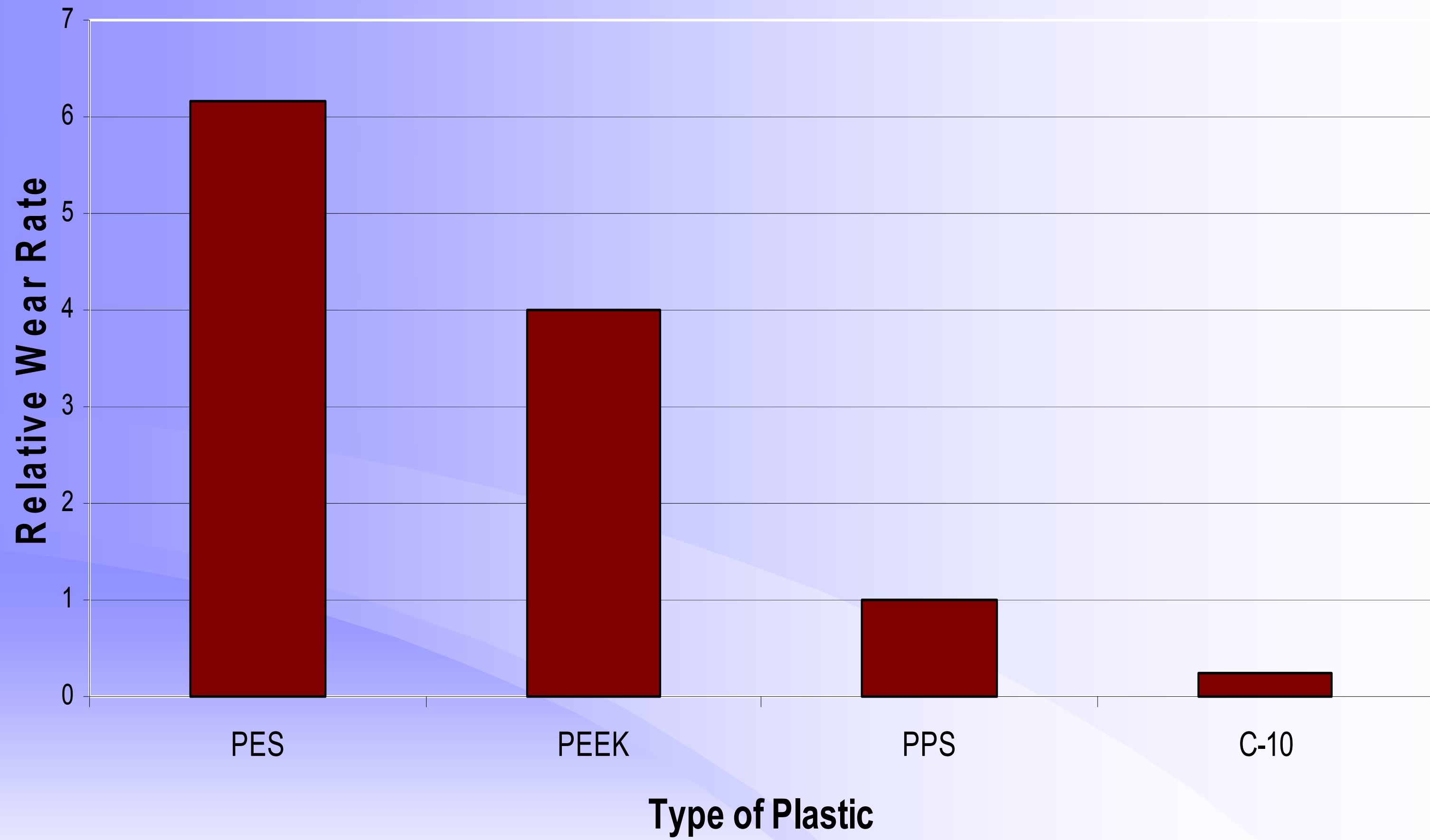
# Comparison of Semplastics' C-10™ Material to Typical Ring Plastics

| Plastic* | Specific Gravity | Tensile Strength (PSI) | Tensile Mod. Of Elasticity (PSI) | Sheer Strength (PSI) | Hard Shore D | COF | Relative Wear Rate |
|---|---|---|---|---|---|---|---|
| **PC** | 1.20 | 10,500 | 320,000 | 13,000 | 80 | N/A | N/A |
| **PET** | 1.41 | 12,400 | 460,000 | 8,000 | 87 | 0.20 | 1.20 |
| **PES** | 1.37 | 12,200 | 385,000 | 9,000 | 80 | N/A | 3.30 |
| **PEEK** | 1.31 | 16,000 | 500,000 | 8,000 | 85 | 0.40 | 1.52 |
| **PPS** | 1.35 | 13,500 | 500,000 | 9,000 | 85 | 0.40 | 1.00 |
| **C-10™** | 1.42 | 10,500 | 420,000 | 9,000 | 87 | 0.21 | 0.35 |

*The plastics described above include the following: PC (polycarbonate), PET (Polyethyleneterephalate), PES (Polyethersulfone), PEEK (Polyetheretherketone), PPS (Polyphenylsulfide), and C-10™ (Trademark of Semplastics)

# Tungsten Slurry Ring Wear Data



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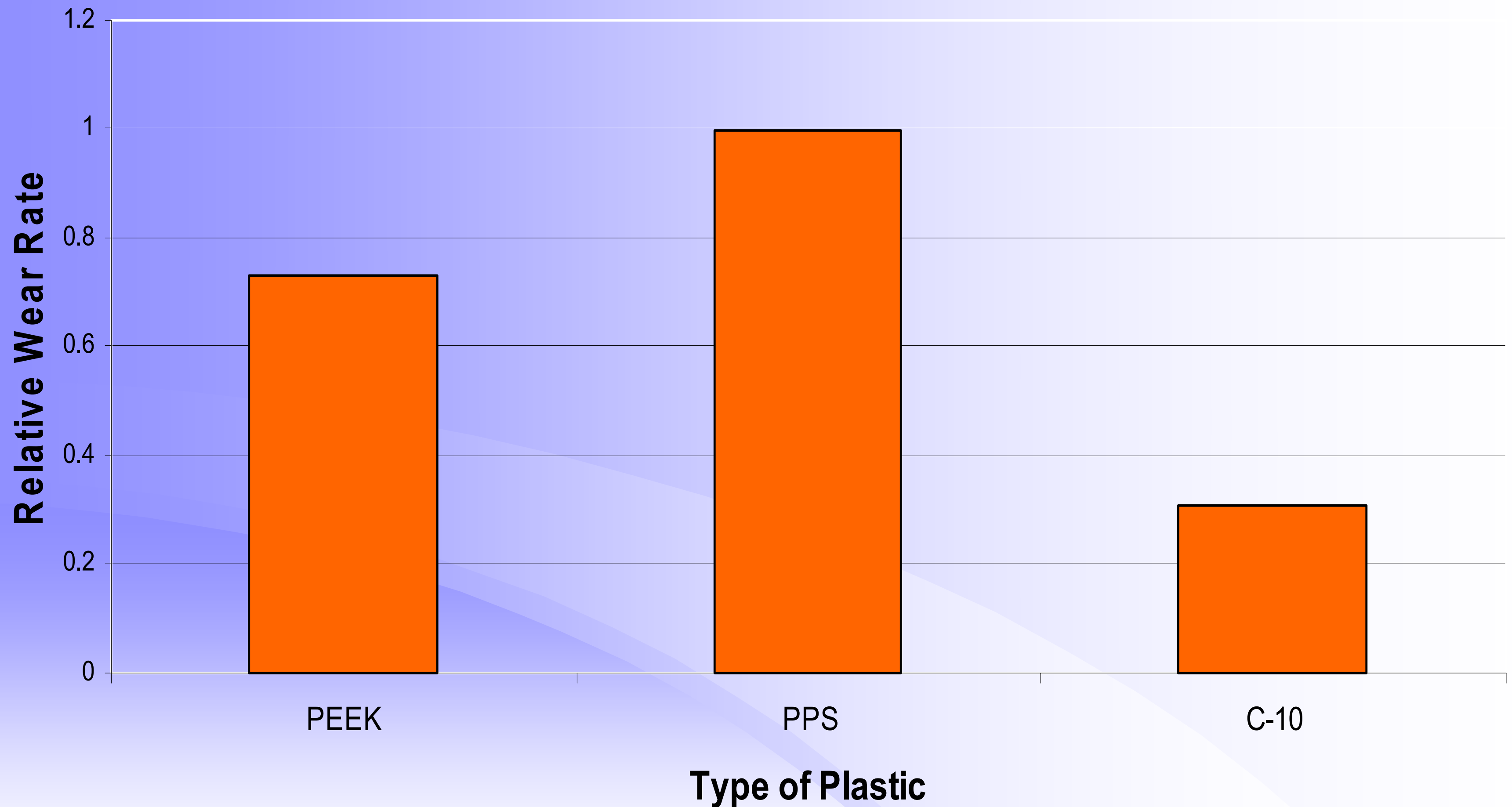
# Copper Slurry Ring Wear Data



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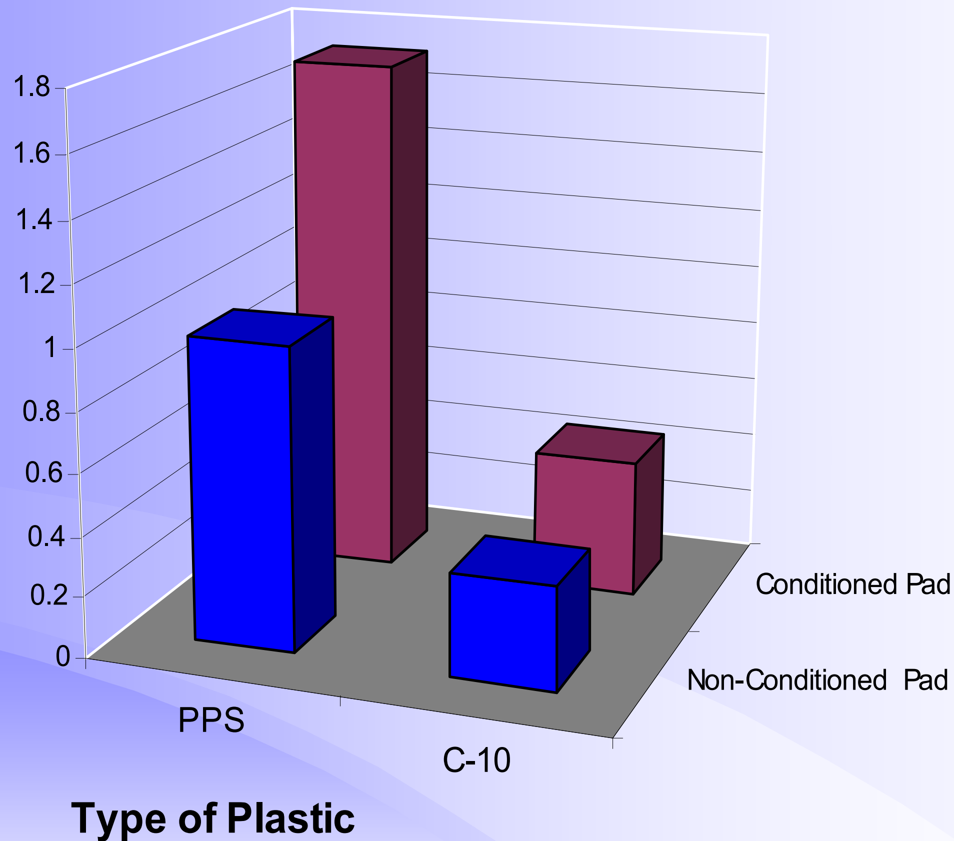
# Dielectric Slurry Wear Data



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# Customer Partnering Success

## IPEC 472

- Issues identified as premature insert failures, warpage and premature cracking
  - Superior insert engineering coupled with ULTRAFLAT™ manufacturing process solved issue
- Ring performance demonstrated at over 20,000 wafer passes for customer’s tungsten CMP process
- Demonstrated over a 2.5X extension in ring lifetime compared to OEM product
- Semplastics engineered solution exceeded customer expectations

# Normalized CoO Example
## Applied Materials

| | Ring Life | | | Carrier Cost/Wafer Pass | | | Total Cost/Wafer Pass | | |
|---|---|---|---|---|---|---|---|---|---|
| Process Technology | OEM | Semplastics | Δ | OEM | Semplastics | Δ | OEM | Semplastics | Δ |
| Dielectric | 0.3 | 0.9 | 300% | 0.14 | 0.05 | 66.7% | 1.0 | 0.83 | 17.3% |
| Tungsten | 0.5 | 1.5 | 300% | 0.11 | 0.04 | 63.6% | 1.2 | 1.05 | 12.5% |
| Copper | 1.0 | 3.0 | 300% | 0.06 | 0.02 | 66.7% | 1.3 | 1.18 | 9.2% |

Assumptions:
- 3X improvement in ring lifetime
- 10 test wafers/ carrier rebuild
- 10X improvement in wafer breakage rate
- No difference in electrical yield accounted for

# Example Savings on Annual Spend
## Applied Materials

**Assumption:** 4 level metal process (1 STI, 4 ILD, 4 W)

4,000 wafers/week (36,000 wafer passes)

Net usage: 936 dielectric/year, 562 W/year

Annual spend on OEM (@$800/ring) = $1,198,000

Annual spend on Semplastics (@ 3x life) = $400,000

**Net Annual Spend Reduction = $ 798,000**



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# Example Savings on Wafer Breakage Applied Materials

**Assumption:** 4 level metal process (1 STI, 4 ILD, 4 W)

4,000 wafers/week (36,000 wafer passes)

Net yield 200 die/wafer @ $20 ASP = $4,000/wafer

Semplatics' ring provides 10X mechanical breakage improvement (1/100,000 Vs 1/10,000 POR)

Net improvement of 3.24 wafers lost/week

Annual yield of 168 fewer wafer breakages/year

**Net Annual Yield Improvement = $672,000**

# Summary

- Semplastics brings a unique combination of machining expertise and materials knowledge to the high-tech marketplace
- Large depth of IC industry experience and perspective (65+ years)
- Strong history of supply to demanding IC customers
  - Demonstrated capacity and upside swing reserve capacity
- Strong IP position
  - ULTRAFLAT™, C-10™ technologies
  - All-plastic AMAT ring
- Demonstrated improvements in CoO and wafer breakage
  - Demonstrated 2.5X lifetime increase with potential for 5X
    - Ability to significantly reduce customer's CoO
    - Proven 66% CoO reduction at customer site
  - Significant reduction in ring related wafer breakage
  - Potential to improve WIWNU and copper defectivity