

High Performance Pad Conditioning (HPPC) Arm for Advanced Pad Conditioning

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CMP BU
Applied Materials

Introduction

- Advanced technology nodes at 14nm and below present greater challenges with WIWNU, WTWNU and WIDNU due to stringent process requirements, complex process technologies and device structures .
- As CMP involves multiple components such as consumables, polisher and the material being polished, variation from each of the component becomes more important at advanced nodes.
- Extensive work has been done around consumables such as slurry, pads, but limited work has been done around pad conditioning.
- Pad conditioning plays a big role in process stability, consumable life, defectivity and planarization.
- Traditionally pad conditioning has been done more in the over conditioning regime and at higher downforce to achieve target removal rates and uniformity control, but this generally limits the consumable life.
- For advanced device nodes, lower pad conditioning downforce and less variability is desired.
- Here we demonstrate the use of HPPC arm to monitor disk to disk variation that can impact removal rate, WTWNU, WIWNU and consumable life.

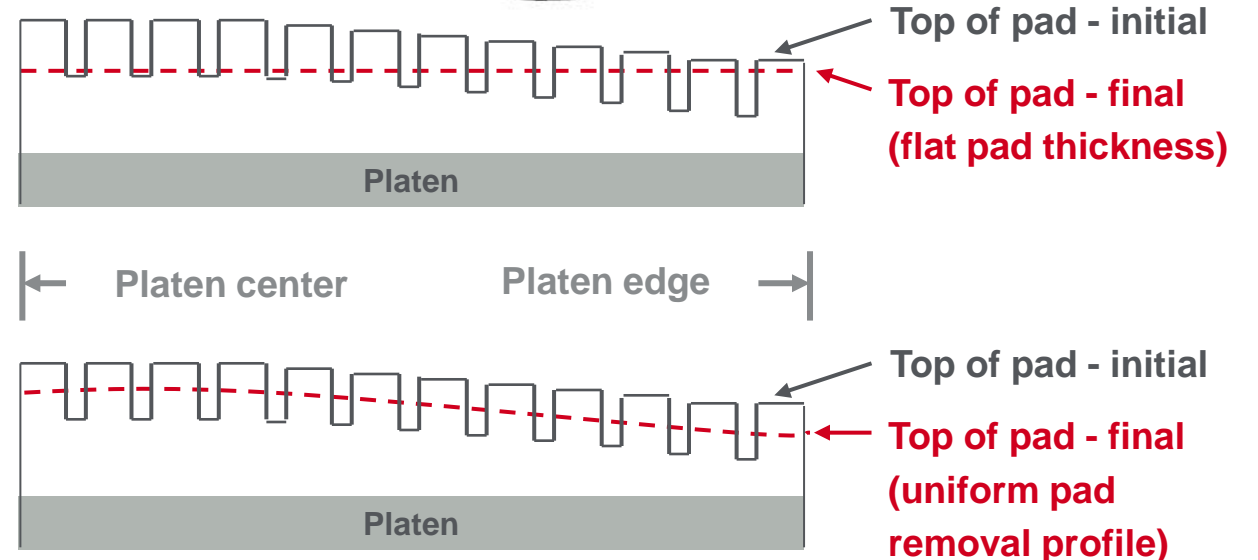
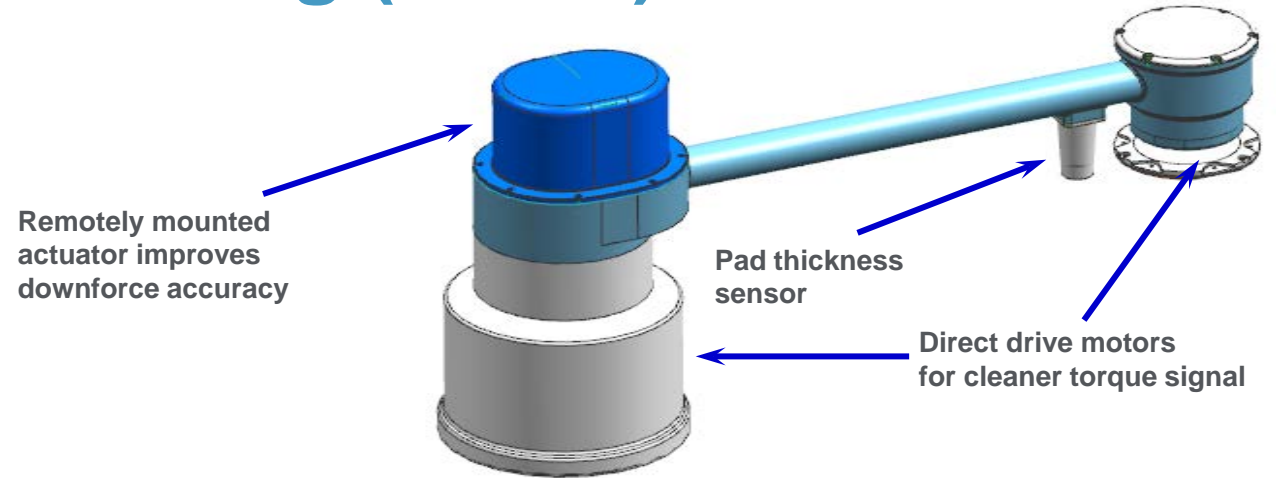
High Performance Pad Conditioning (HPPC) Arm

Challenge

- Pad life variability may affect process stability
 - ▶ Potential impact to pad lifetime
 - ▶ Potential impact to WIW uniformity

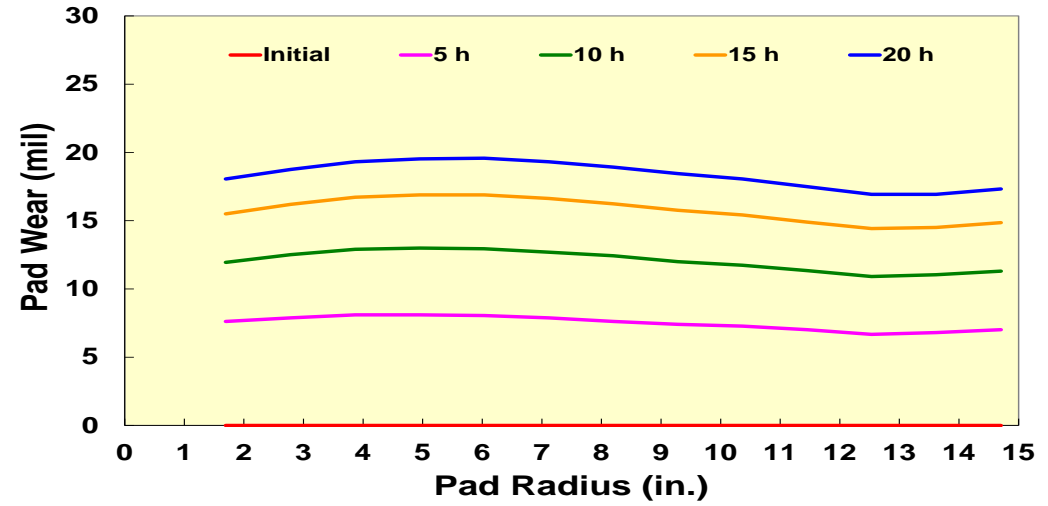
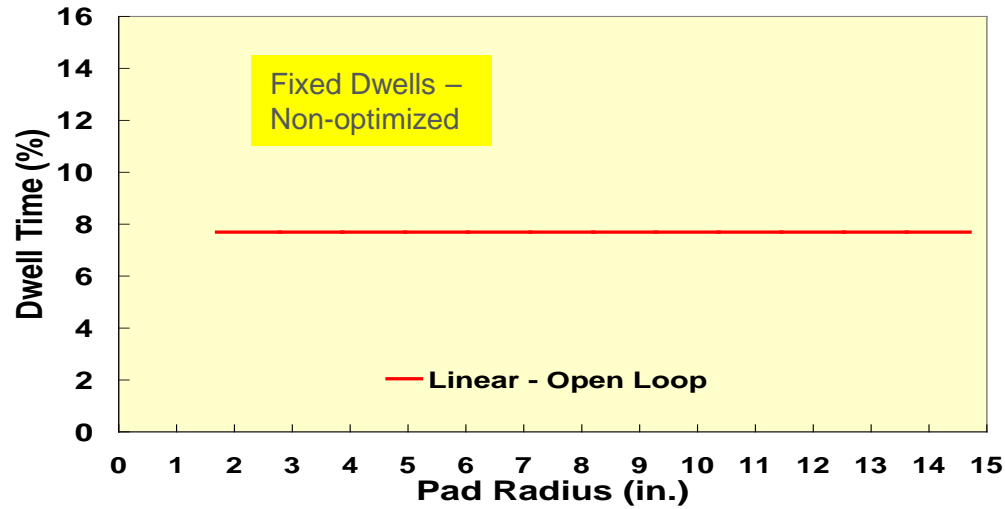
Approach

- Pad wear monitoring provides indicator of consumables change
- Pad profile CLC enables uniform pad wear through pad life
- PC disk installation health monitor

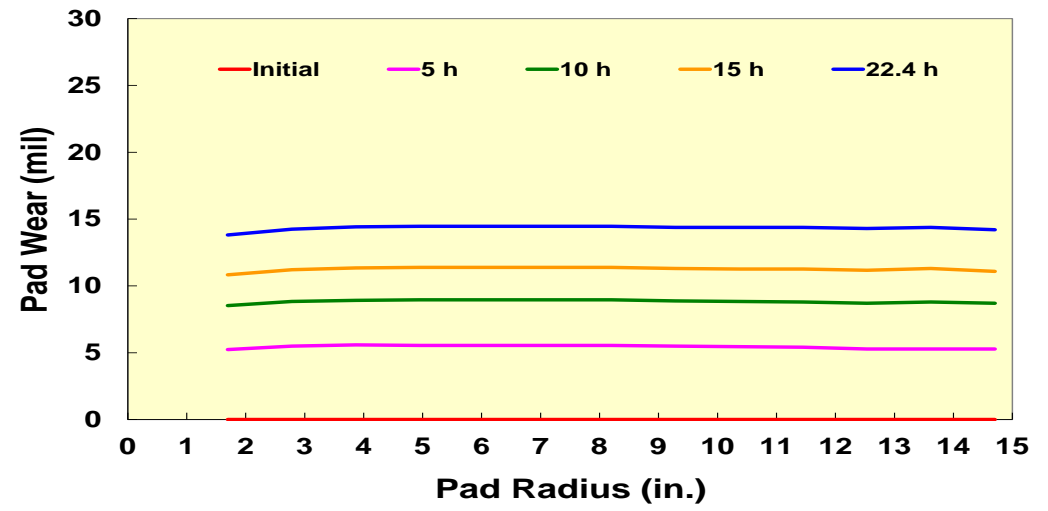
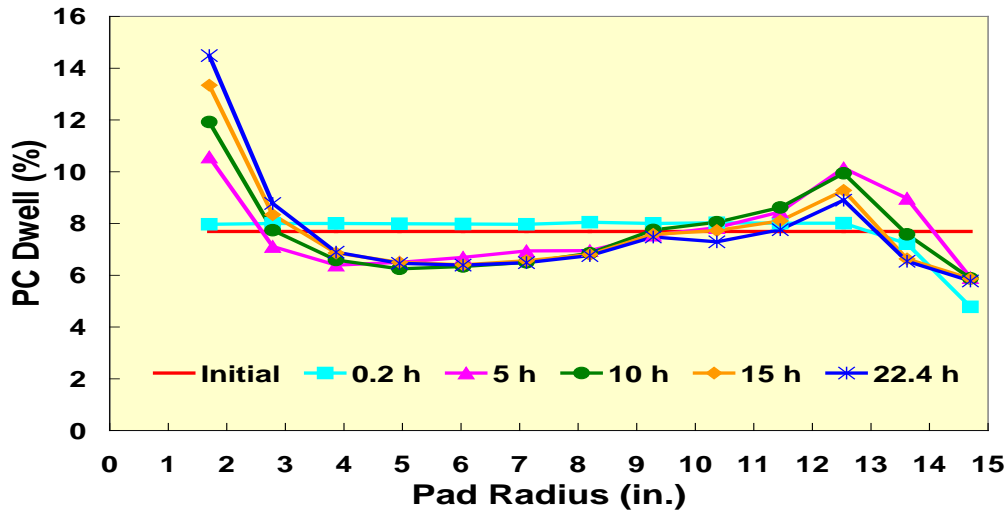


HPPC Enables Pad Wear Monitoring and Pad Profile Stability
HPPC Enables both Accurate Pressure Down Force and Feedback

Pad Profile CLC: Enable Uniform Wear



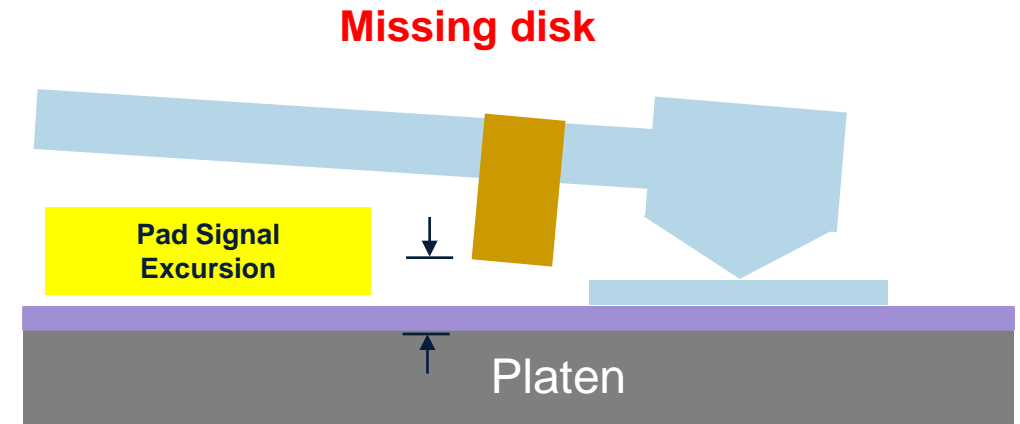
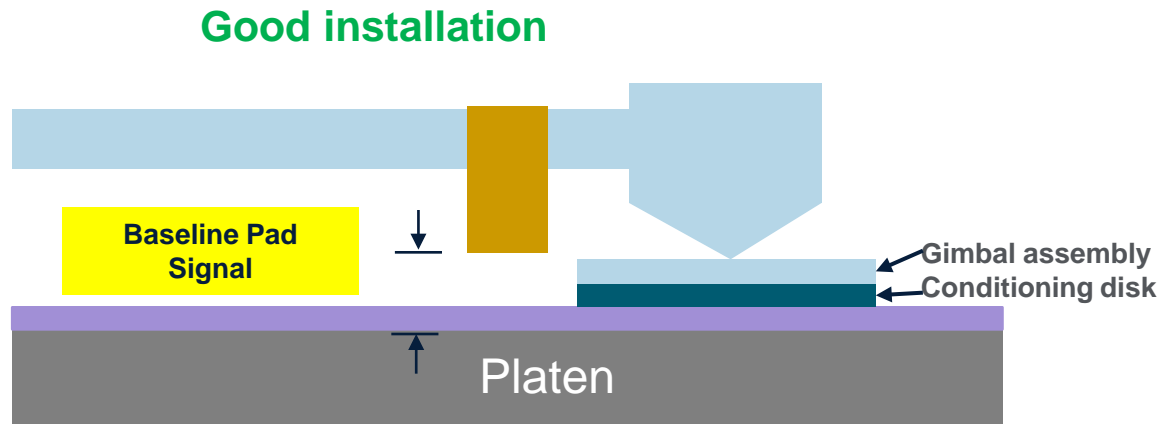
Open Loop



Closed Loop

Improvement in Within-Pad Range Observed with HPPC Profile CLC

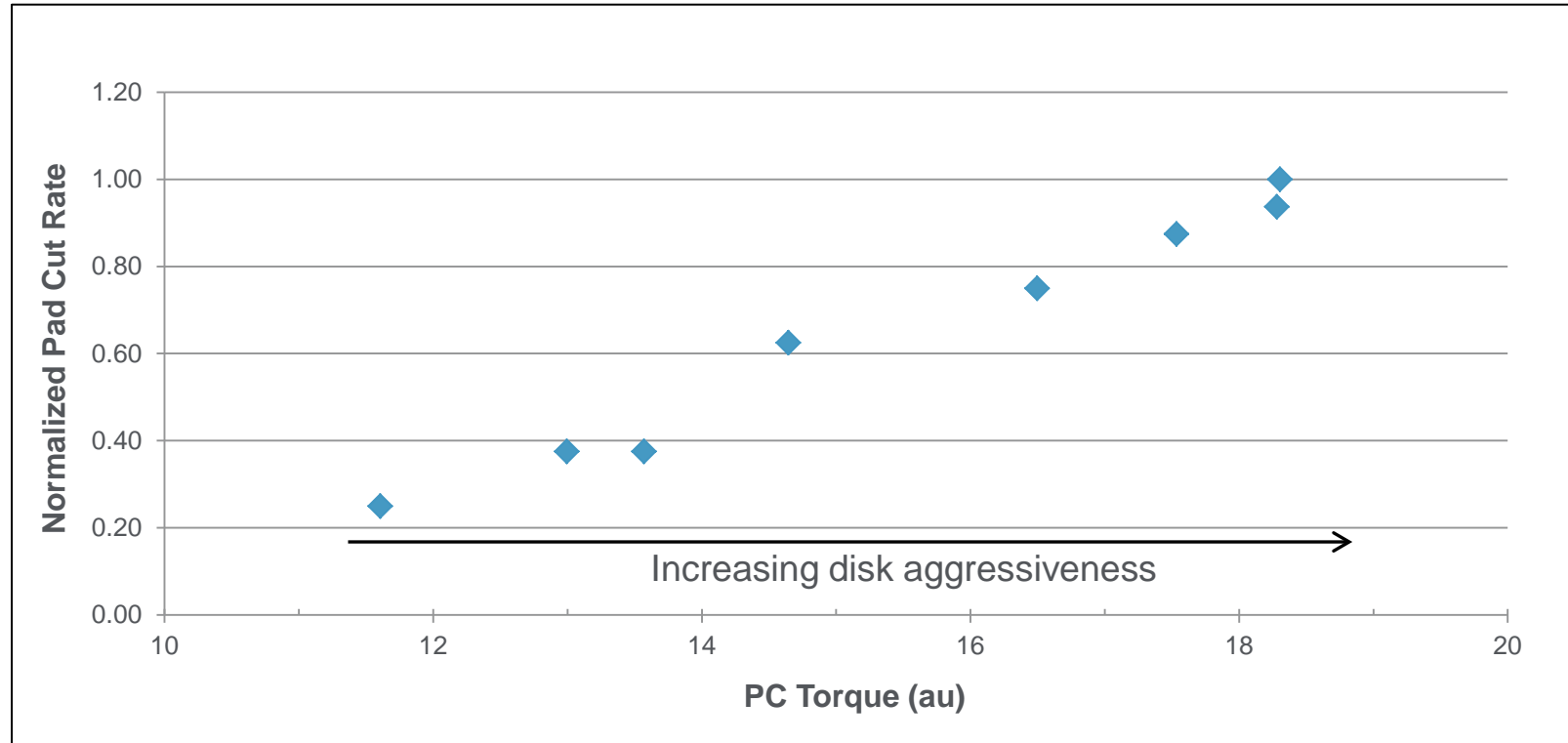
Disk Installation Health Monitor



- HPPC can detect disk installation issues
 - ▶ Missing disk
 - ▶ Torque monitoring can be used to detect wrong disk/consumable installation

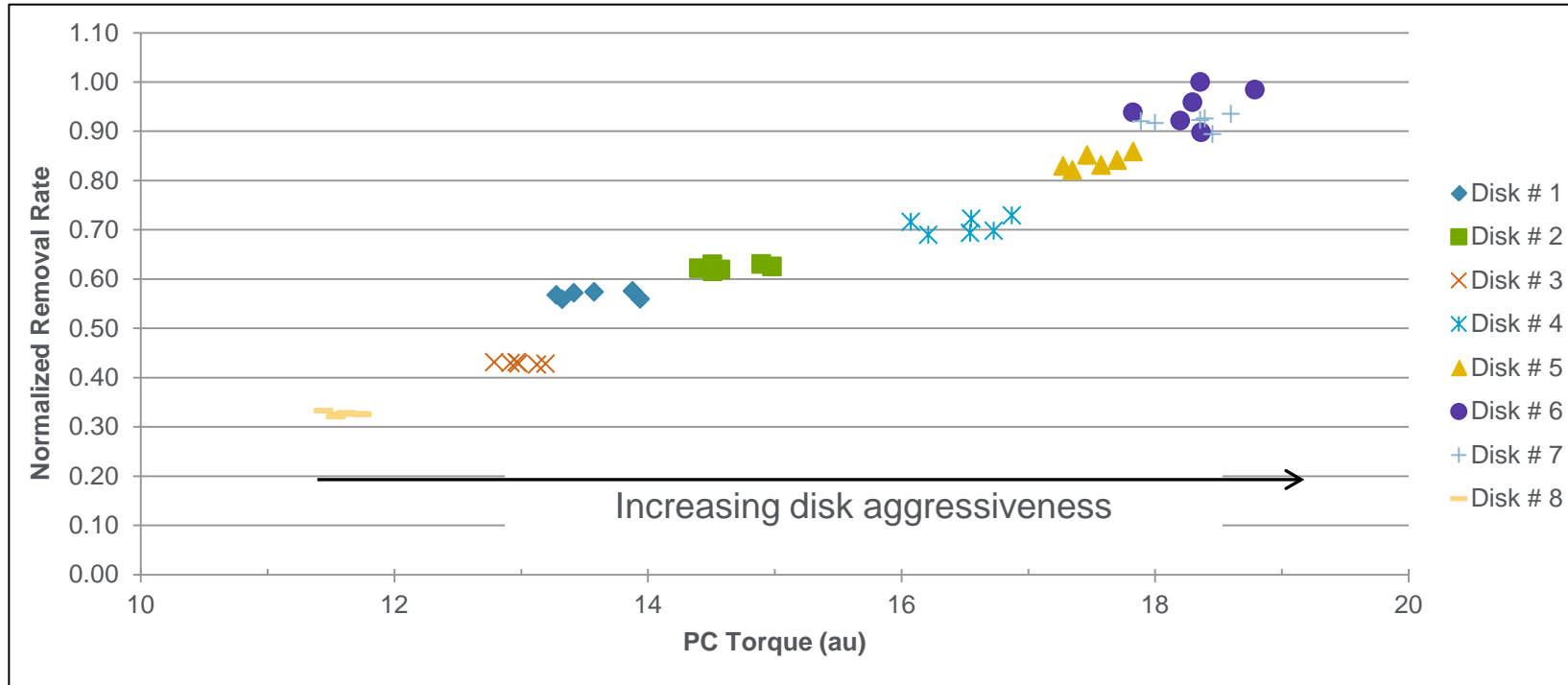
HPPC Health Monitor Enables PC Disk Excursion Control

Pad Conditioner Torque vs. Pad Cut Rate



Disk aggressiveness has direct impact on pad cut rate and can impact pad life

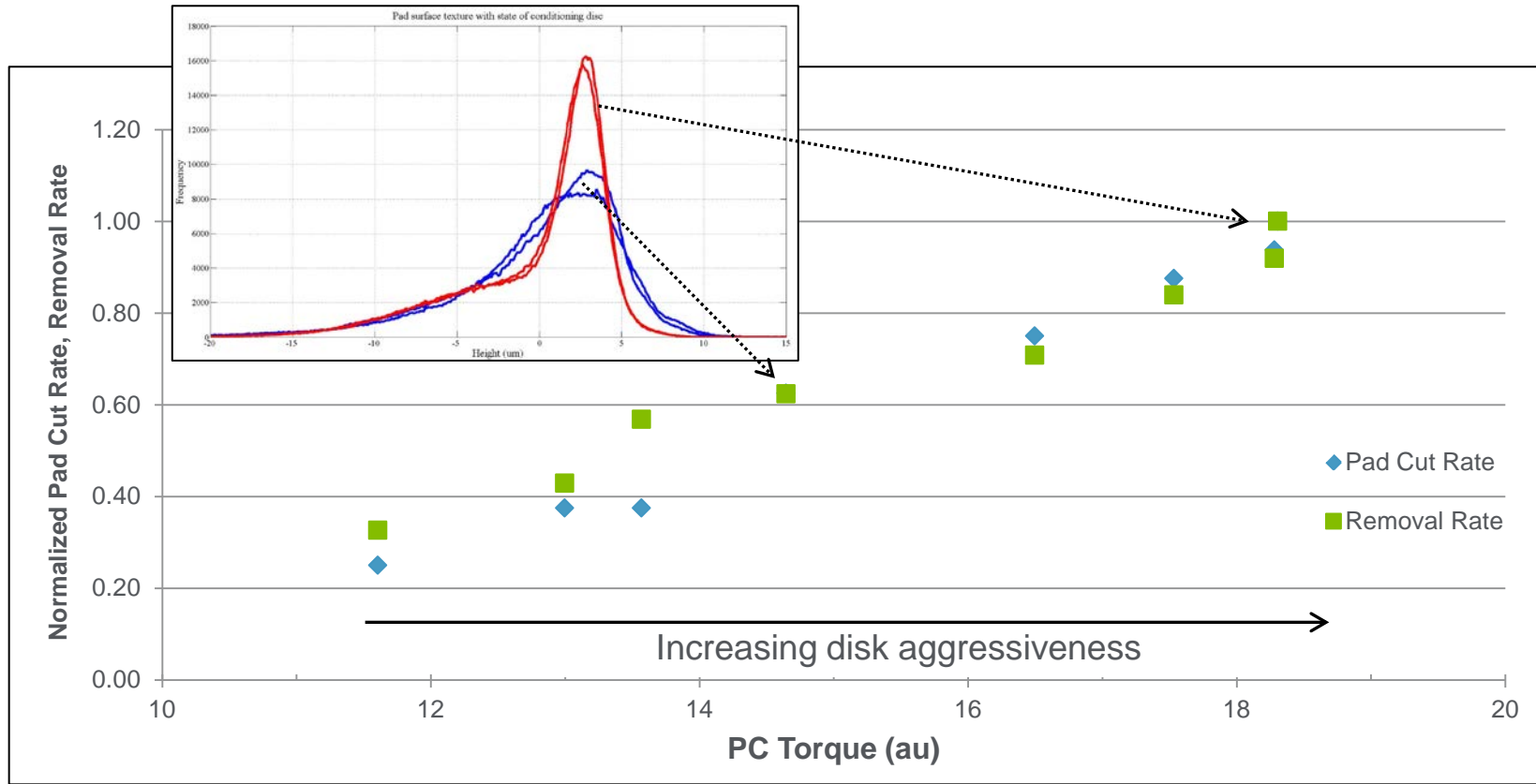
Pad Conditioner Torque vs. Oxide Removal Rate



* Removal rate comparison post pad break-in

Variation in disk aggressiveness results in removal rate variation impacting process stability

Pad Conditioner Torque vs. Oxide Removal Rate, Pad Cut Rate



PC torque can be used to track any disk-to-disk variation. Aggressiveness variation also impacts pad surface roughness.

Summary

- HPPC enables pad wear monitoring, pad profile stability, accurate pressure down force and feedback.
- Improvement in within-pad range is observed with HPPC profile CLC. Stable WTWNU and WIWNU can be achieved with HPPC CLC.
- HPPC health monitor enables PC disk excursion control.
- Disk aggressiveness impacts pad cut rate and pad life.
- Variation in disk aggressiveness results in removal rate variation impacting process stability.
- Aggressiveness variation also impacts pad surface roughness.
- HPPC arm can be used to track disk-to-disk variation to improve process stability and consumable life.
- HPPC arm can be used for pad conditioning optimization and minimize over conditioning to improve consumable life.



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