A comparison study using Mipox pads for Copper CMP

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Presentation Outline

- Introduction of Mipox
- Objectives
- Tools and consumables used
- Experimental details
- Results
- Conclusions

Introduction of Mipox

- Headquarters: Nihon Micro Coating Co., Ltd., Tokyo, Japan founded 11/21/1925.
- U.S. Subsidiary: Mipox International Corporation, Hayward, CA.
- Technology: Nano surface polishing & abrasive technologies
- Products: Polishing pads for CMP, HD, etc., polishing films, polishing slurries, polishing coolant, polishing machines.
- Sales revenue: 107 million U.S. Dollars (Consolidated) in FY2004
- WW Manufacturing and Sales Offices:

  U.S.A., Taiwan, Malaysia, Shanghai, Korea and sales reps. in U.S.A. and Europe.

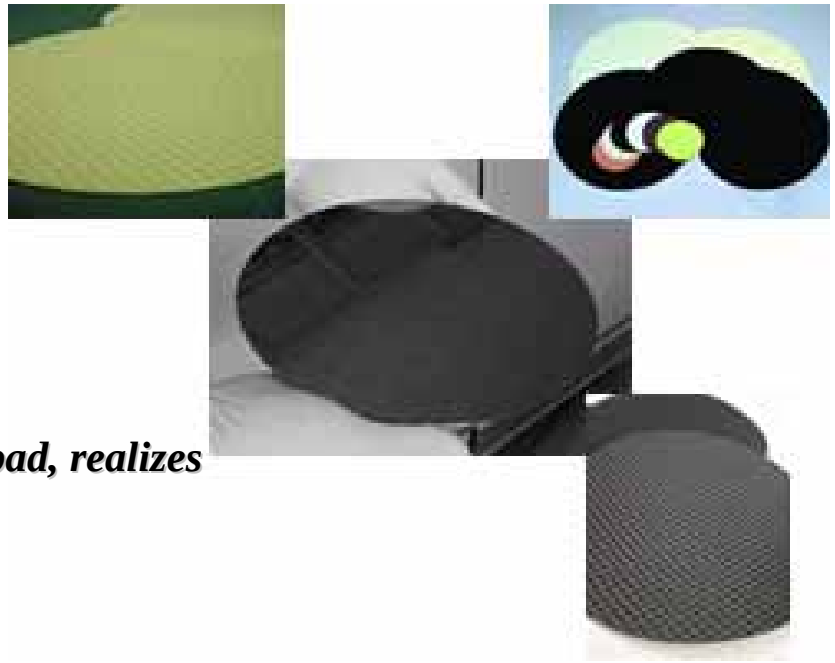
Clarkson UNIVERSITY

NCP pads Concepts

Applications

Oxide CMP (STI, ILD, BPSG)
Cu CMP

- ***Non Cell Structure***
- ***High Planarity***
- ***Consistency***



NCP, Non cell structural hard material CMP pad, realizes high planarity, and consistent performance.

General Information on NCP Pad

- Materials: Polyurethane
- Thickness: 1.0 mm
- Hardness: 75 duro Shore D
- Compressibility: Less than 1.3%
- Available size: Up to 32”
- Grooving: Spiral (Standard)

Objective

- To evaluate the performance of the pads provided by Mipox for copper CMP
- Side-by side comparison with a reference pad to evaluate its performance with respect to a reference pad
- To check the viability of the pad for commercial applications

Tools and Consumables used

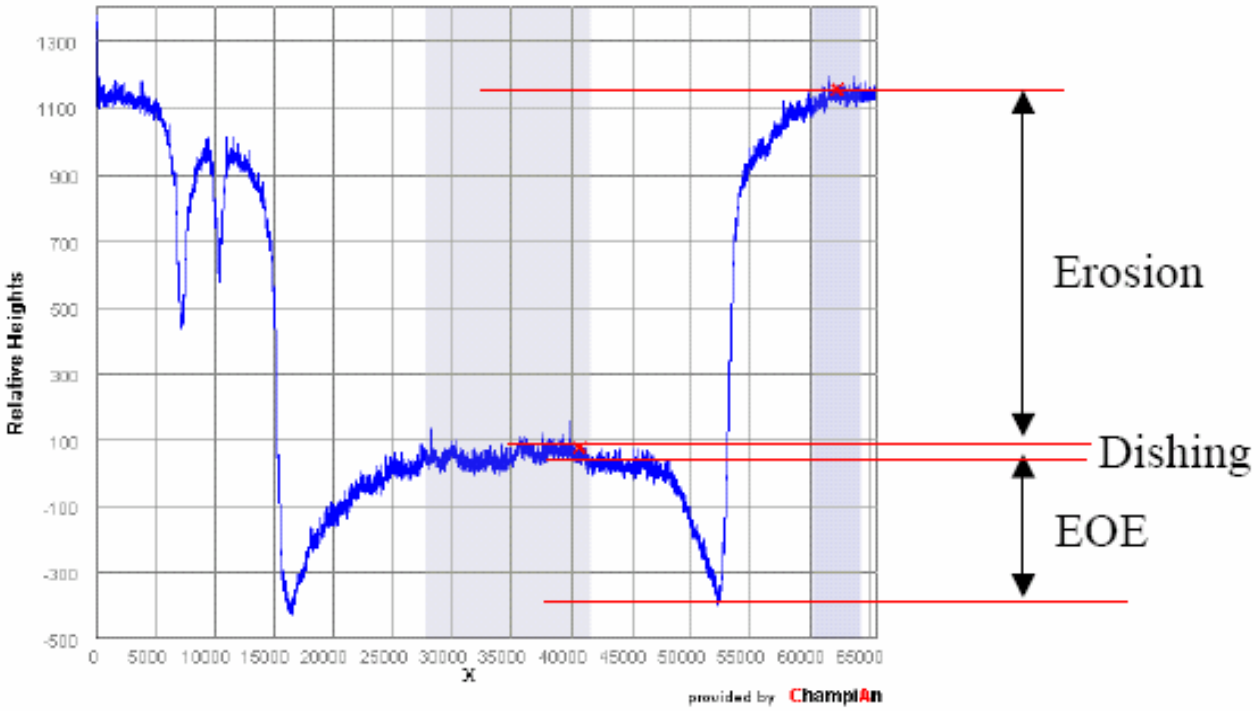
- Polisher: Strasbaugh n-Hance (200mm/300 mm)
- Resistivity mapping tool: Prometrix RS-35E
- Optical profilometer: Burleigh Non-contact optical profilometer
- Stylus profilometer: KLA-Tencor P20H
- Pads: Two NCP pads from Mipox and one reference pad
- Wafers: Cu blanket and patterned test wafers (SKW 6-3 and SKW 6-5) provided by SKW Associates Inc.
- Slurry employed: Proprietary silica and organic based slurry
- Conditioner: System Marshal 4 inch 100 grits

Experimental details

- A small DOE was conducted to evaluated the performance of all three pads under various polishing conditions such as flow rate, table/platen speeds, and down force.
- Blanket wafer evaluation
  - Polishing of blanket wafers at different process conditions followed by ex-situ conditioning to evaluate MRR and WIWNU
  - Surface quality study of the polished wafers
- Patterned wafer evaluation
  - Step-Height Reduction efficiency (SHRE)
  - Final dishing and erosion values after clearing of Cu
  - Edge Over Erosion (EOE) characteristics on the 6-5 wafer

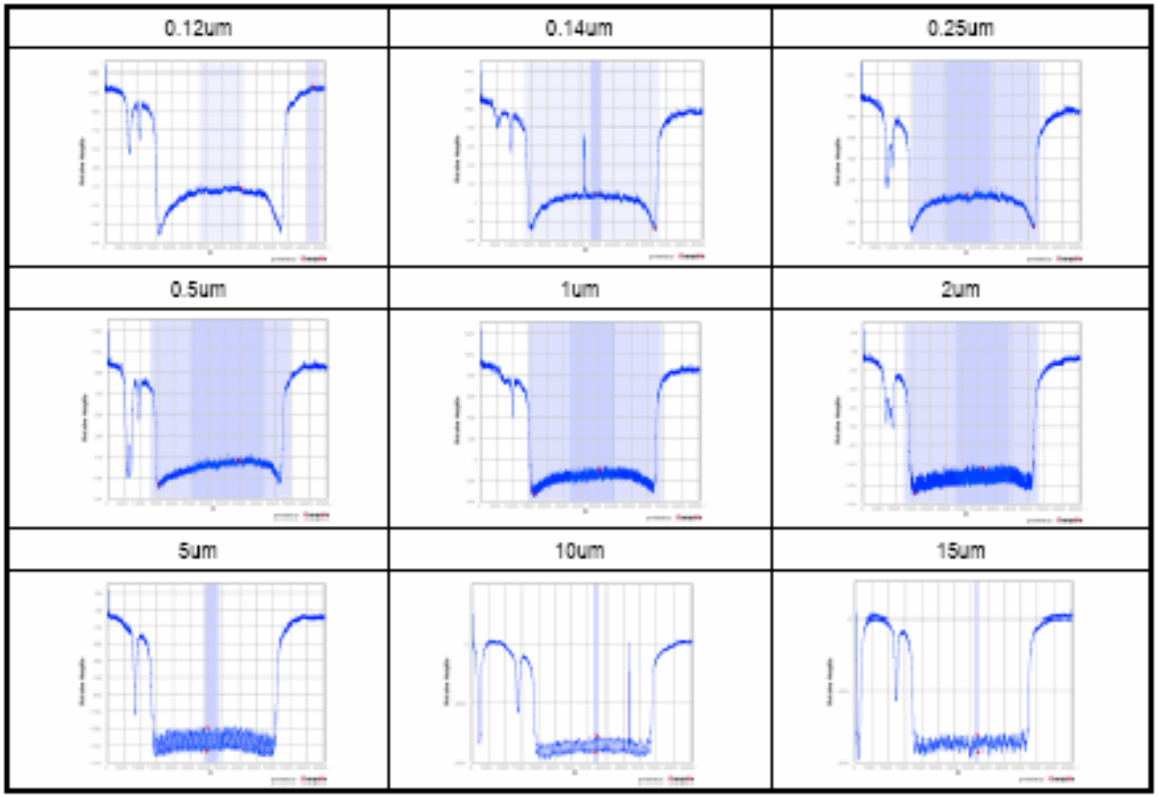
Erosion (total) = Erosion + EOE

Total Cu loss = Erosion (total) + Dishing



(source: SooKap Hahn of SKW Associates. 1/2005)

(1) Effect of line widths (0.12~15um) at 750x750um arrays of PD 50%



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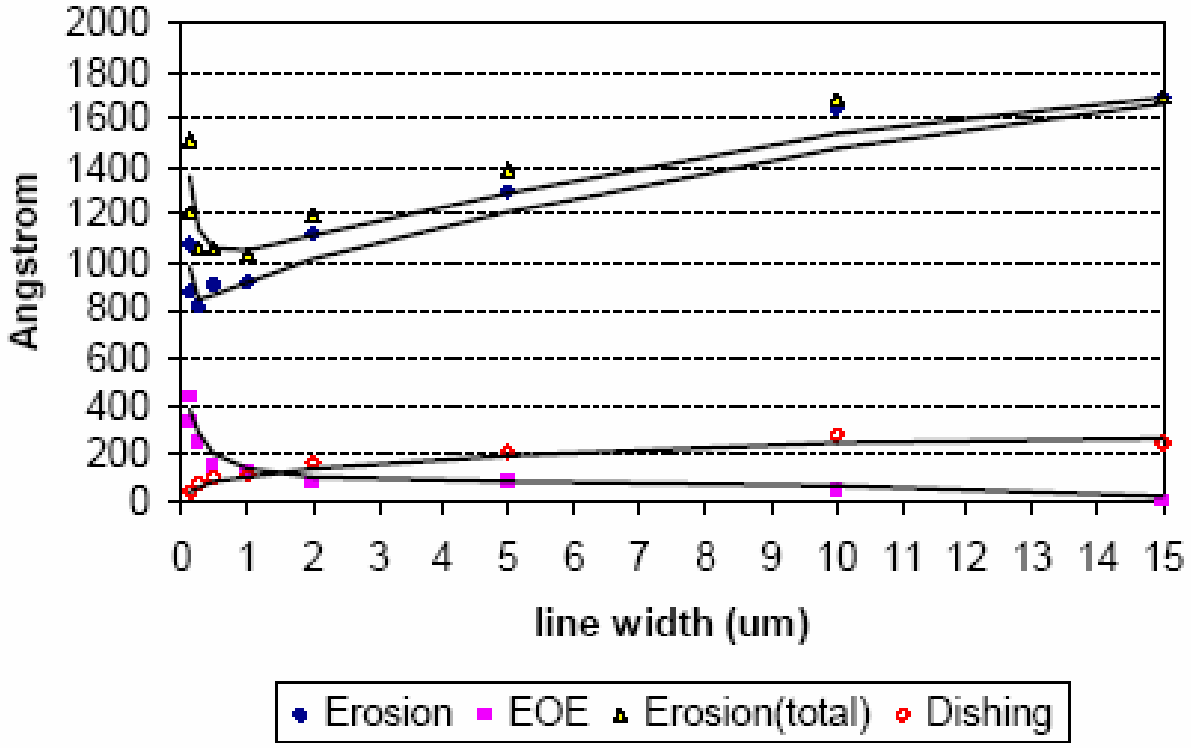
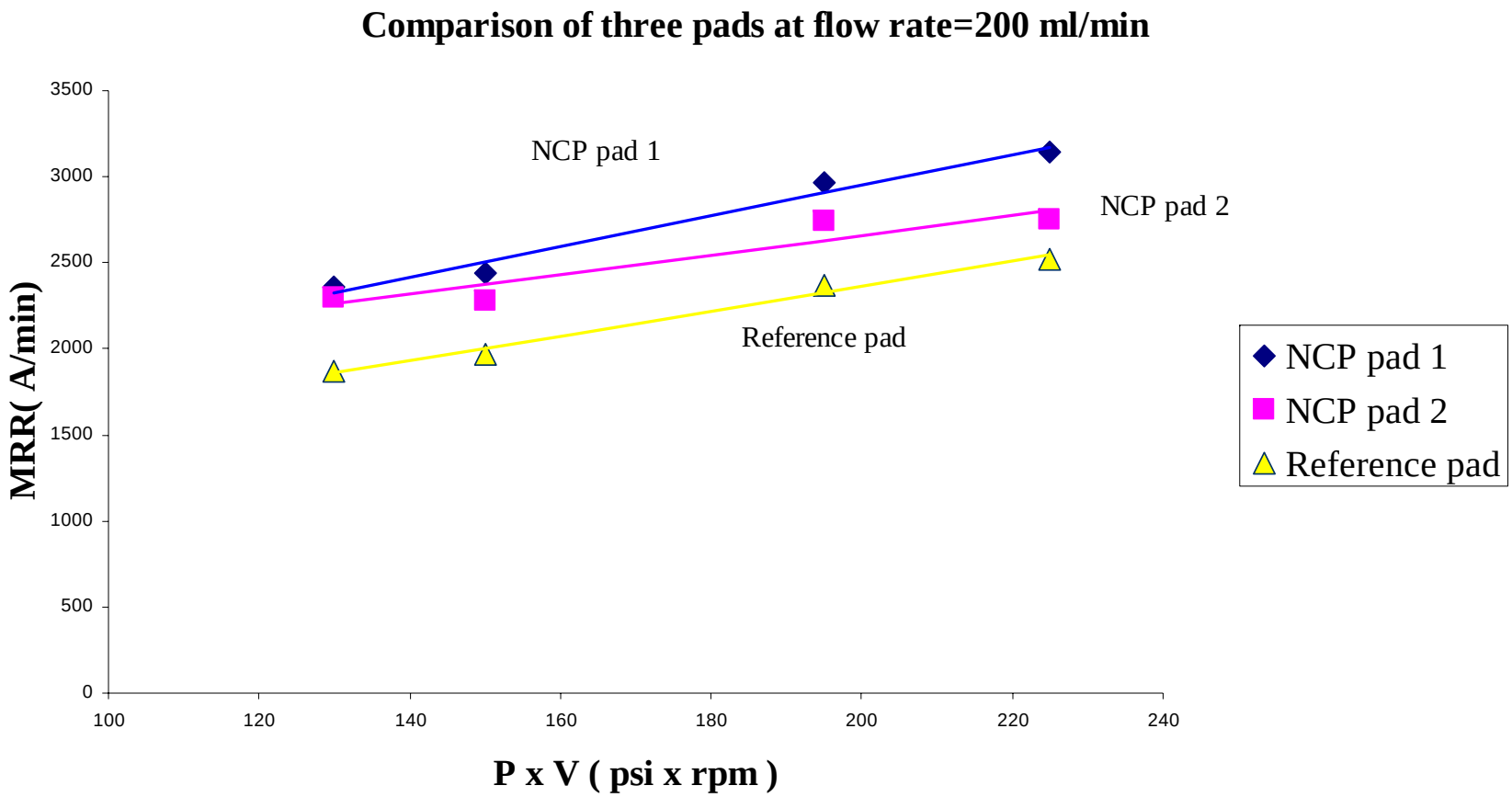


(source: SooKap Hahn of SKW Associates. 1/2005)

Blanket wafer evaluation

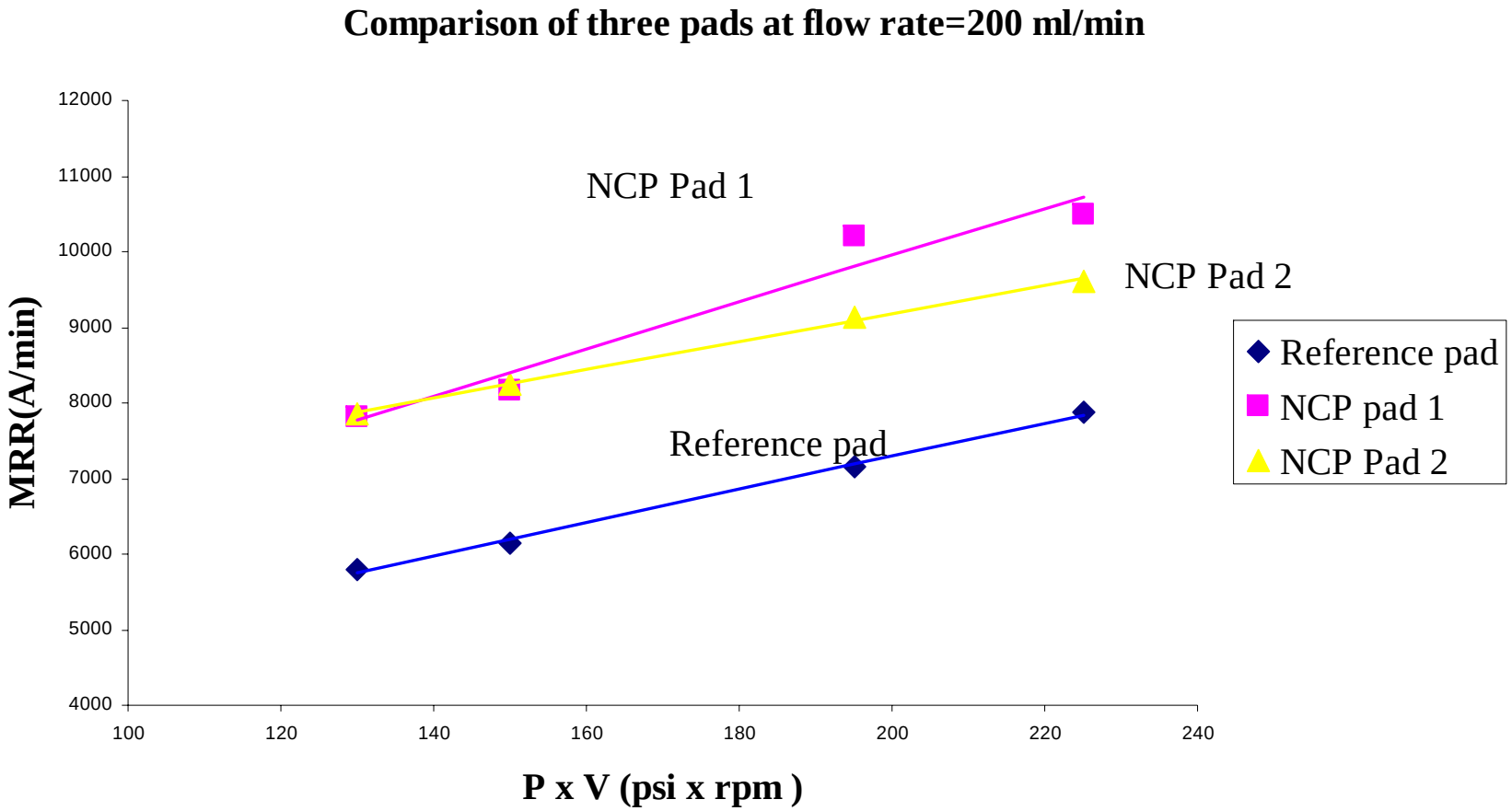
- Blanket wafers were polished at different conditions of pressure, table/speed and flow rate
  - Down force=2 and 3psi
  - Table/carrier speed= 75/65 and 65/55 rpm
  - Flow rate=200 and 350 ml/min
- Ex-situ conditioning-
  - Number of sweeps and time =5 cycles of 36 seconds each
  - Conditioner/table speed=30/30 rpm
  - Conditioner down force=7 lbs
  - DI water flow rate=300 ml/min
- Surface quality evaluation
  - Surface roughness evaluation of polished substrates

Blanket wafer results
Material removal rates vs. PV at lower flow rate for silica slurry



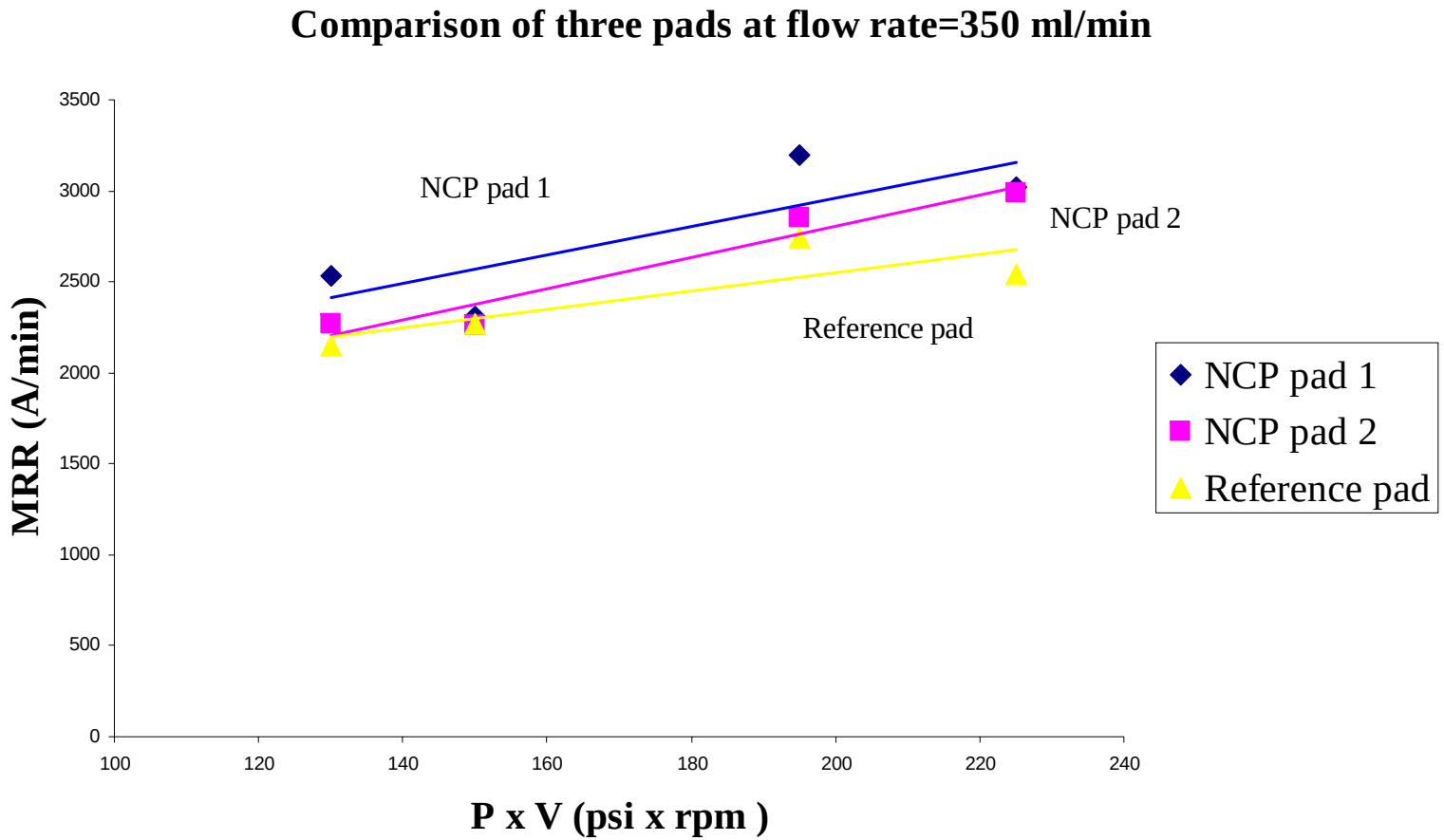
The NCP pads yielded higher removal rates compared to the reference pad, NCP1 has Prestonian slope similar to reference pad

Blanket wafer results
Material removal rates vs. PV
at lower flow rate for organic slurry



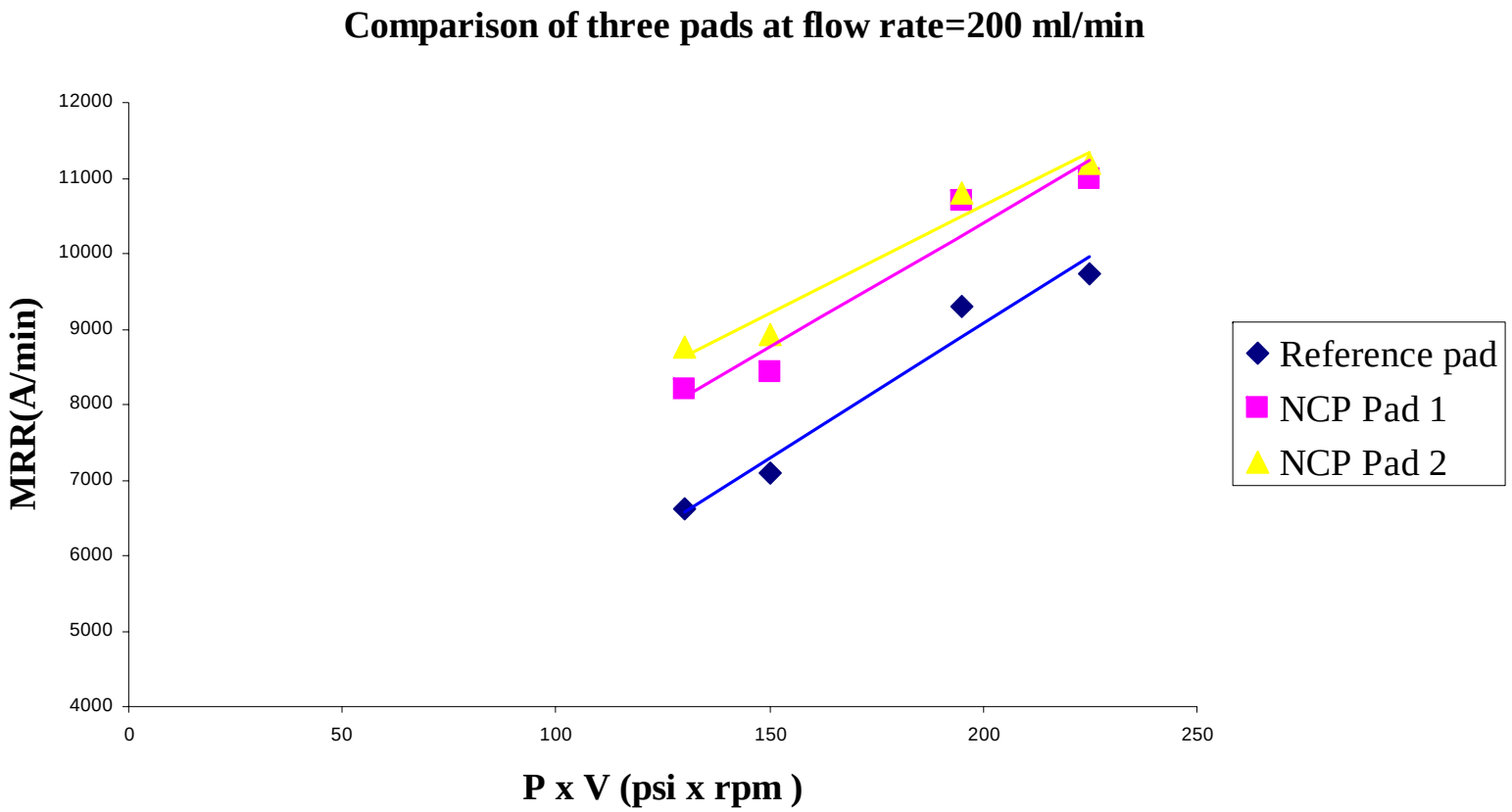
Similar trends were observed for organic based slurry

MRR vs. PV at higher flow rate for silica abrasive slurry



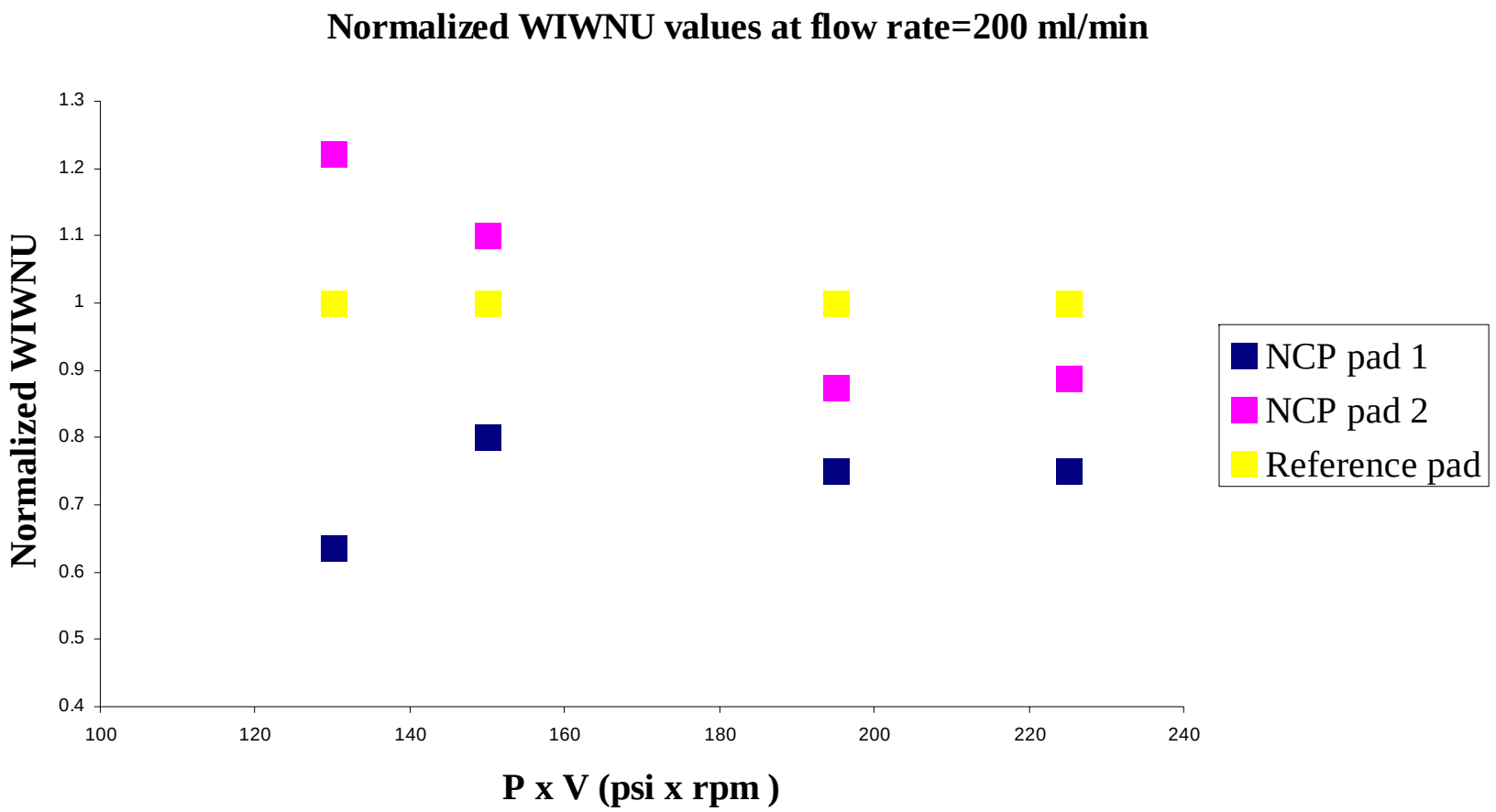
Material removal rates and Prestonian slopes were slightly higher with the NCP pads at higher slurry flow rates

MRR vs. PV at higher flow rate for organic abrasive slurry



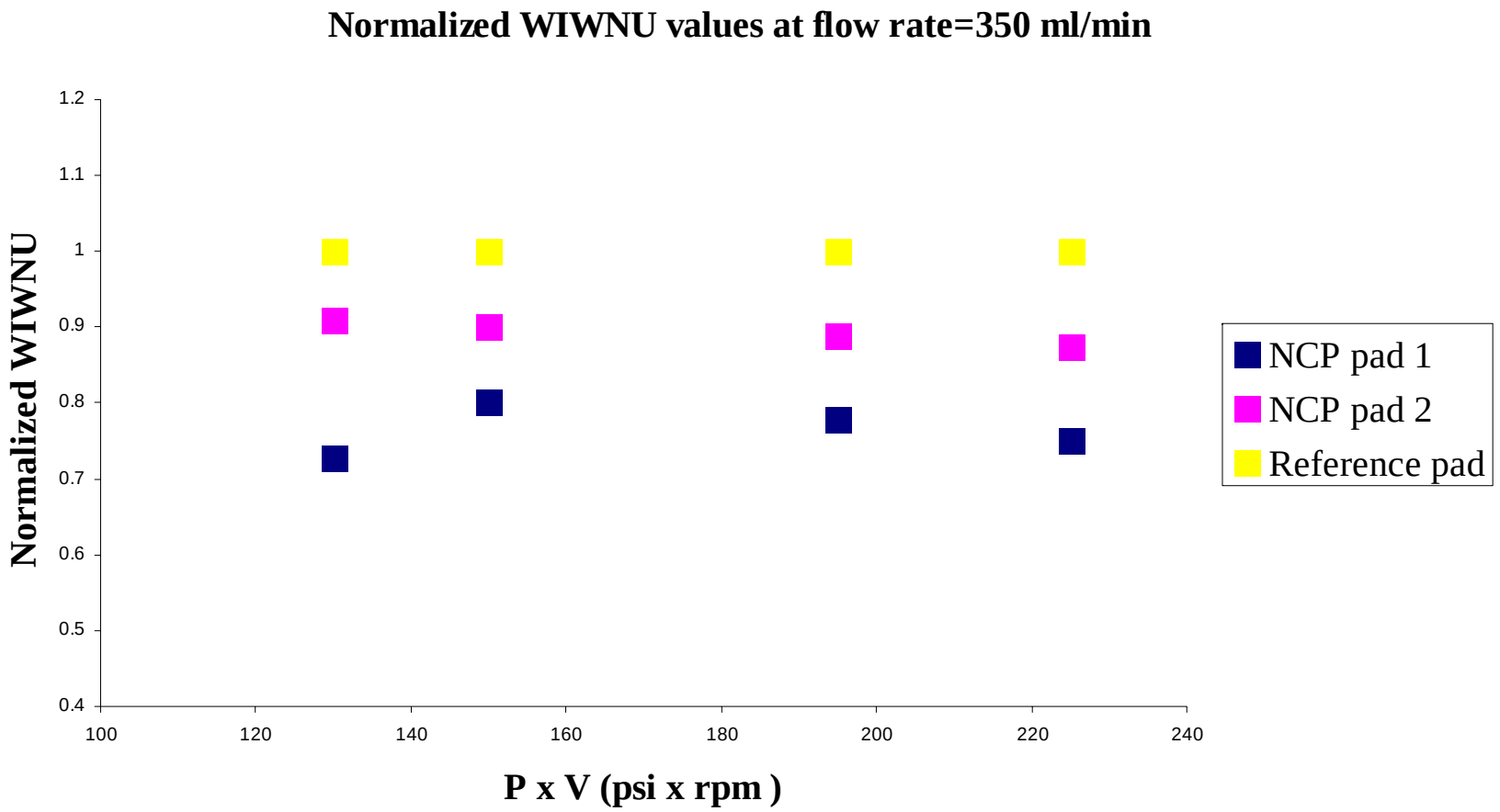
Again, similar trends were observed for organic based slurry

Comparison of normalized WIWNU values at lower flow rate



WIWNU values with NCP pad 1 were observed to be better than the reference pad at lower flow rate conditions

Normalized WIWNU comparison at higher flow rate



WIWNU values with both the NCP pads were observed to be better than the reference pad at higher flow rate conditions

Surface quality images of the polished blanket wafers

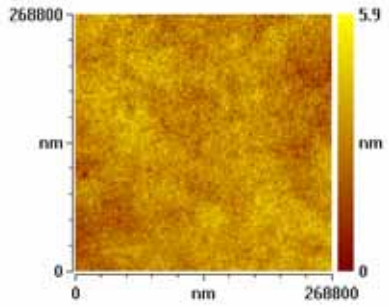


Image	
Mean	0.00
Sq	0.71
Sa	0.57
Peak/Valley	5.94
Skewness	-0.16
Kurtosis	3.04

NCP pad 1

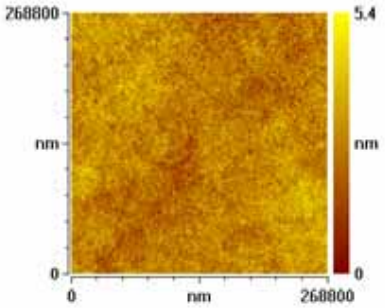


Image	
Mean	0.00
Sq	0.65
Sa	0.52
Peak/Valley	5.37
Skewness	0.00
Kurtosis	2.98

NCP pad 2

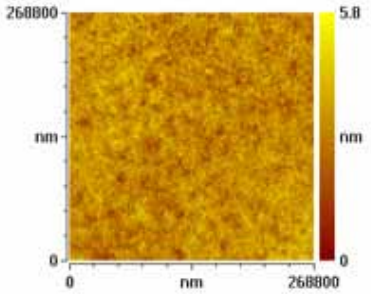


Image	
Mean	0.00
Sq	0.65
Sa	0.52
Peak/Valley	5.80
Skewness	-0.11
Kurtosis	3.03

Reference pad

The surface quality of the polished wafers were similar on all the three pads

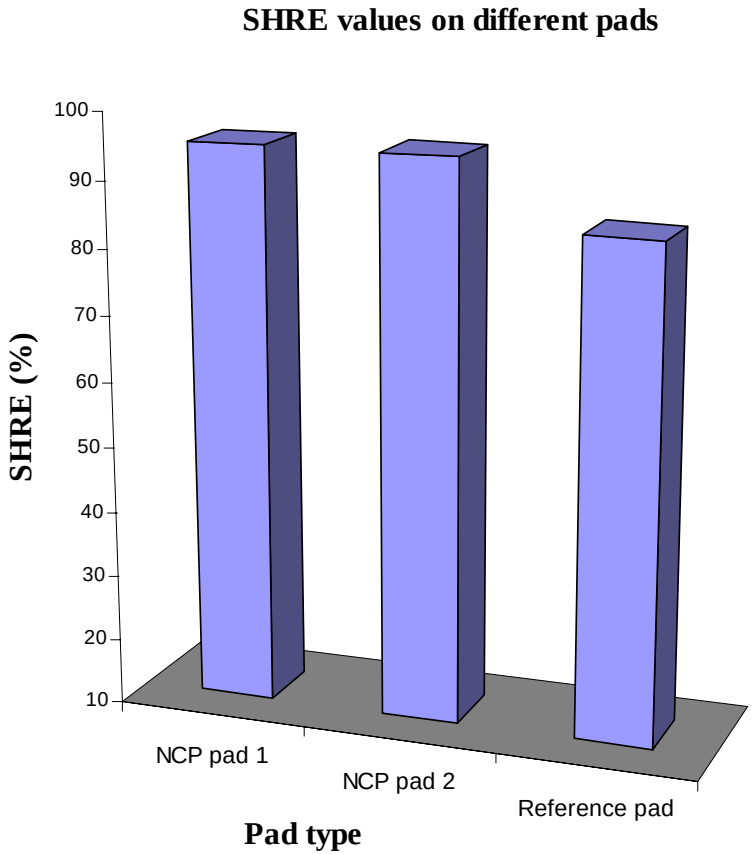
Patterned wafer evaluation

- Patterned wafers 6-3 and 6-5 were polished at the best process condition depending on the blanket wafer evaluation
- Process condition for patterned for polishing

  Down force=3psi,Table/carrier speed=75/65 and flow rate=200ml/min
- SKW 6-3 wafer evaluation
  - Step-height reduction efficiency for the first step in the iterative polishing process
  - Final dishing and erosion values at various features after complete copper clear
- SKW 6-5 wafer evaluation
  - Edge over erosion characterization

Comparison of SHRE

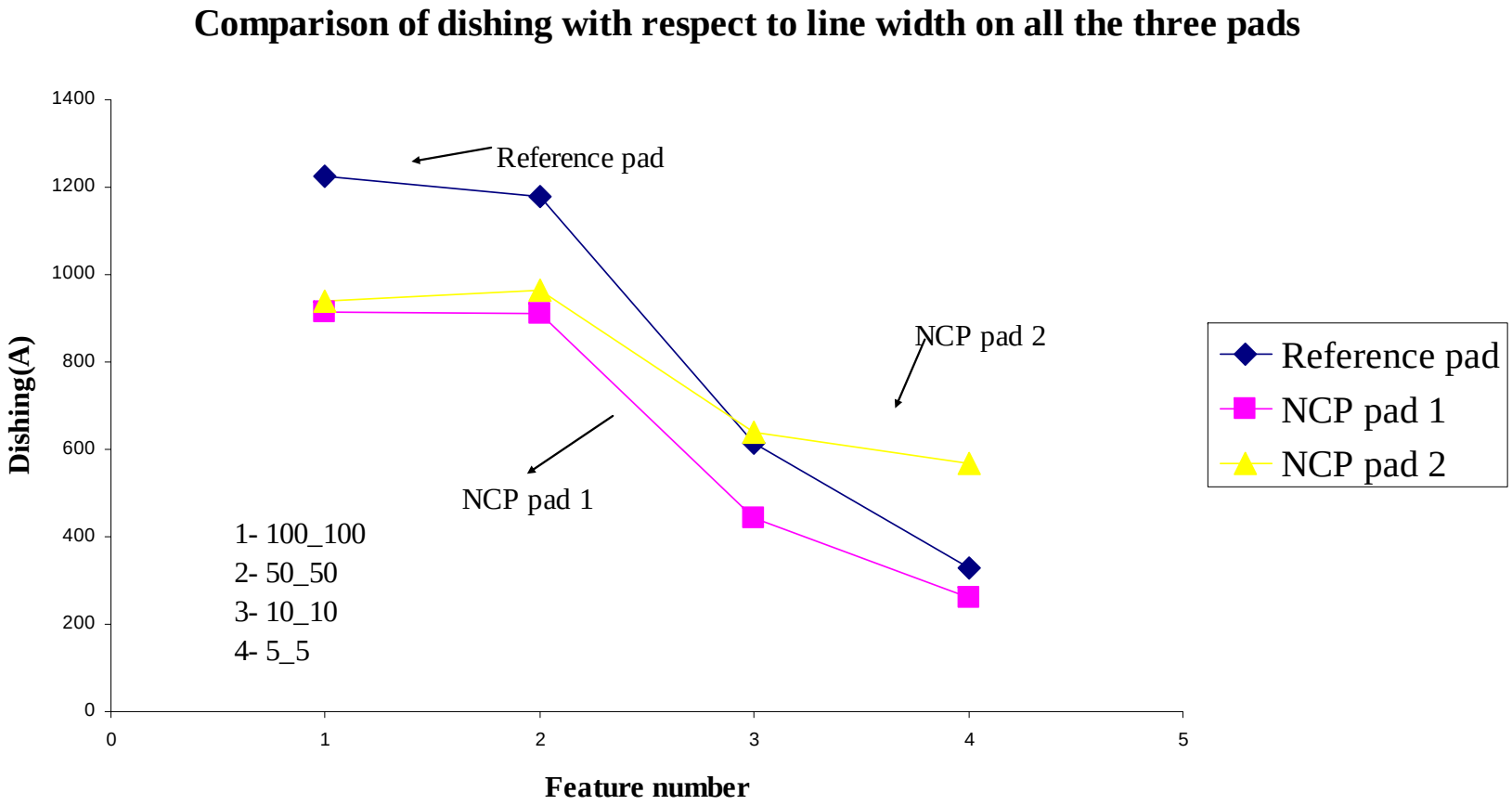
SHRE(%) =(change in step-height)/ (change in the thickness) *100



Average of 100_100 and 50_50 micron features at edge, middle and center dies of the wafer

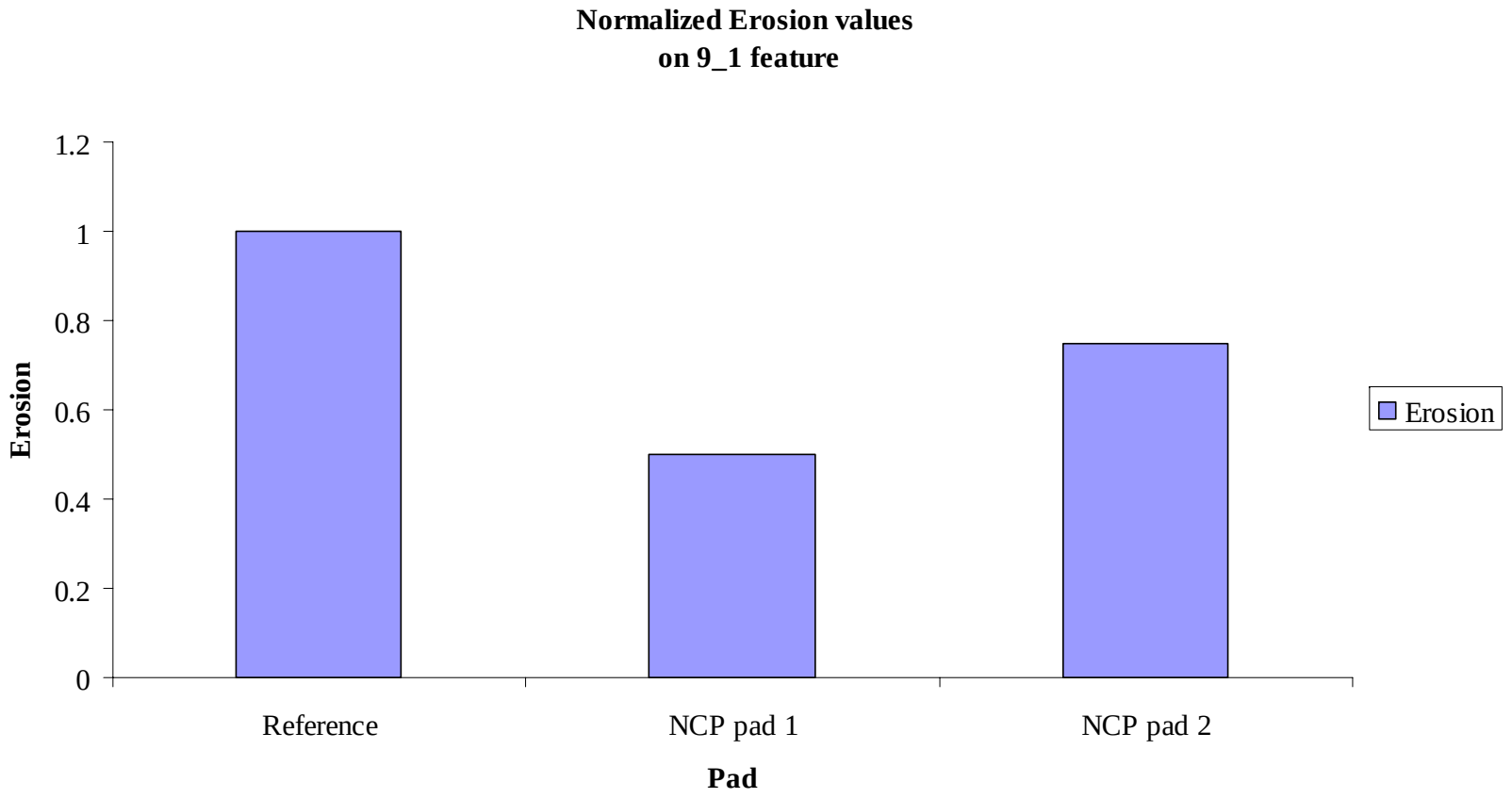
SHRE values were comparable for all the three pads

Dishing with respect to line width on all the three pads



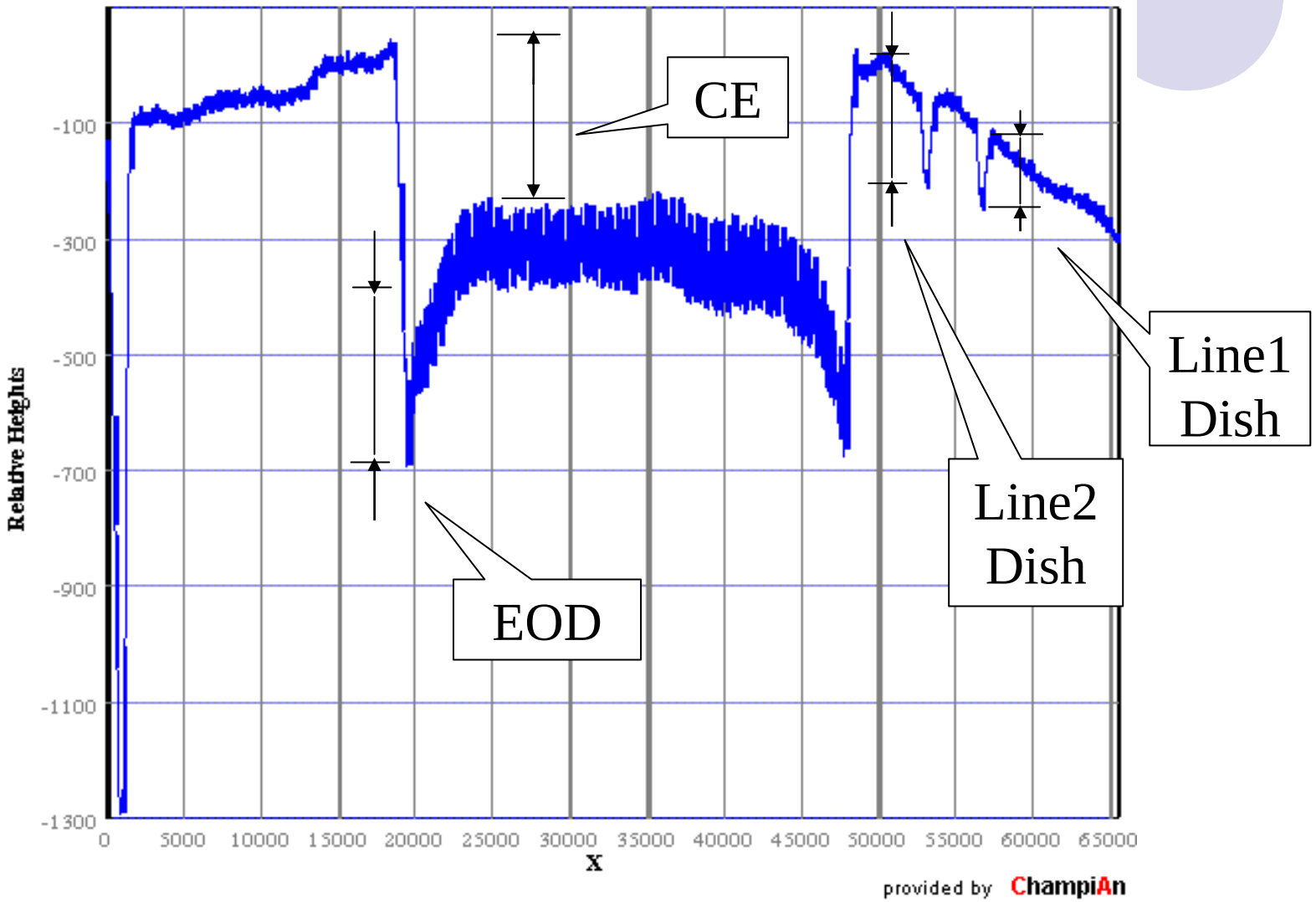
The NCP pad 1 behaved similar to the reference pad
Dishing with the NCP pad 2 was less sensitive to the line width

Normalized erosion values after complete Cu removal



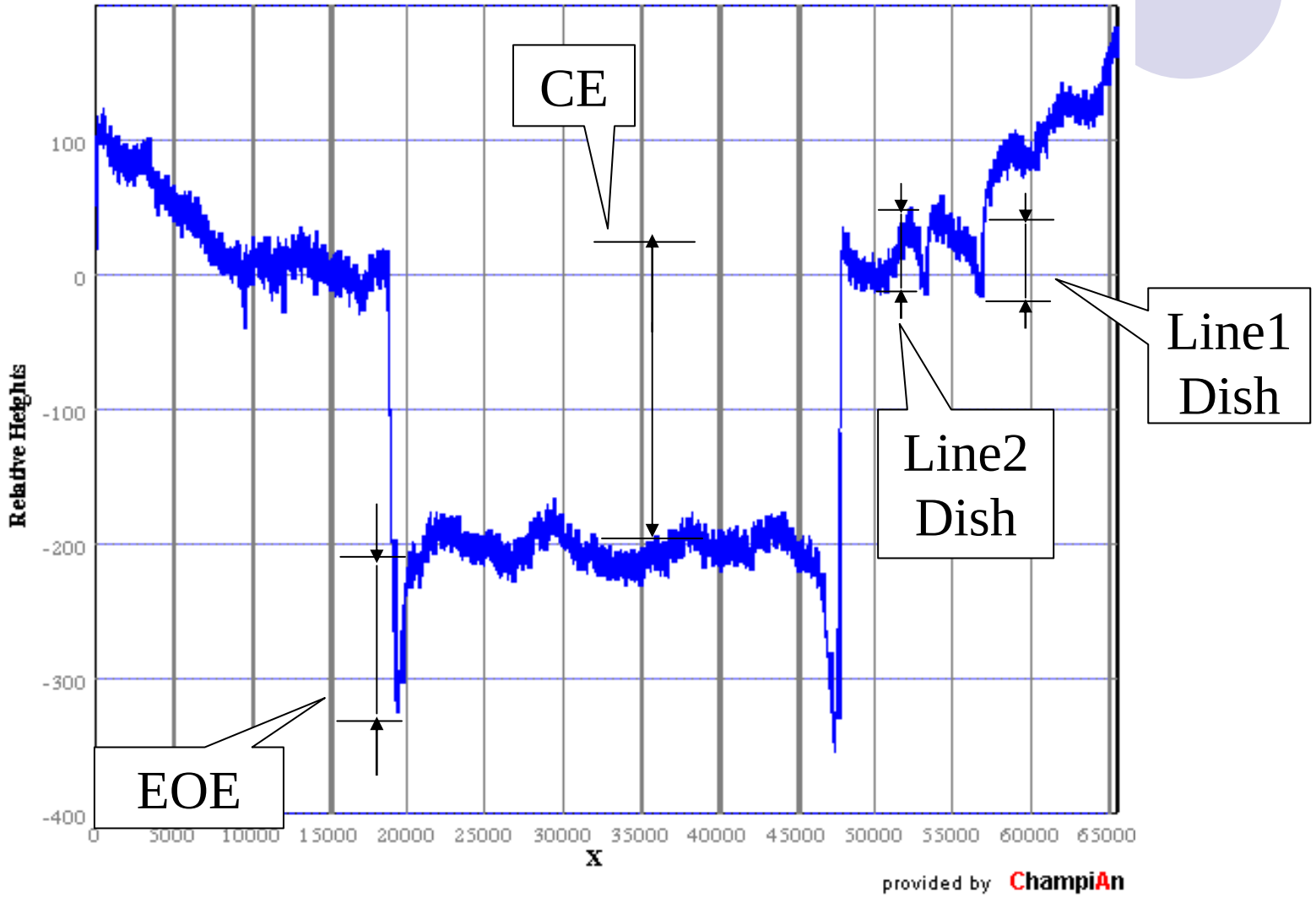
NCP Pad 1 yielded better erosion results

Slurry 1



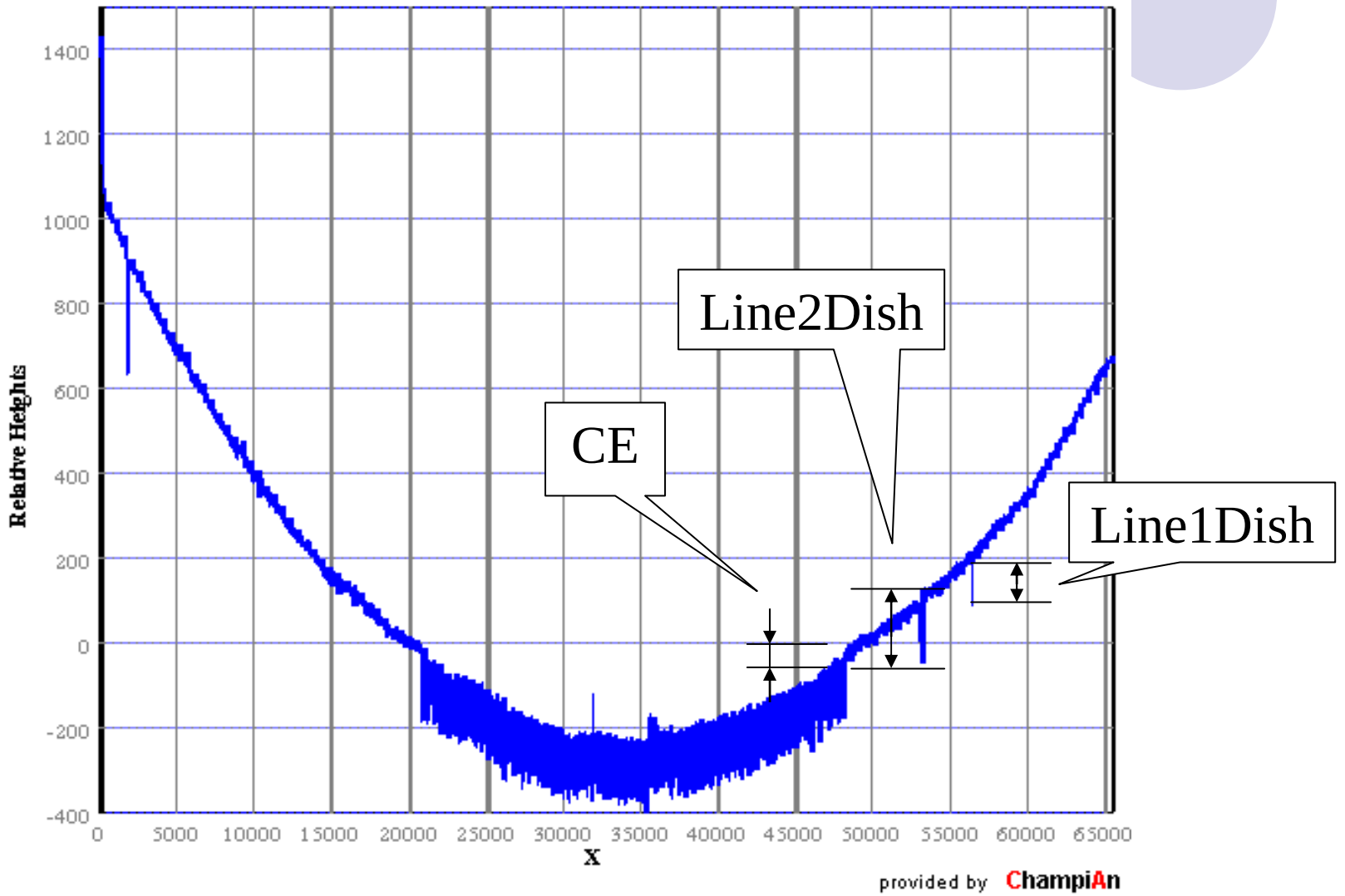
Line1Dish (Å)	Line2Dish (Å)	EOD (Å)	CE (Å)	Array Dish (Å)
192	231	305	264	162

Slurry 1



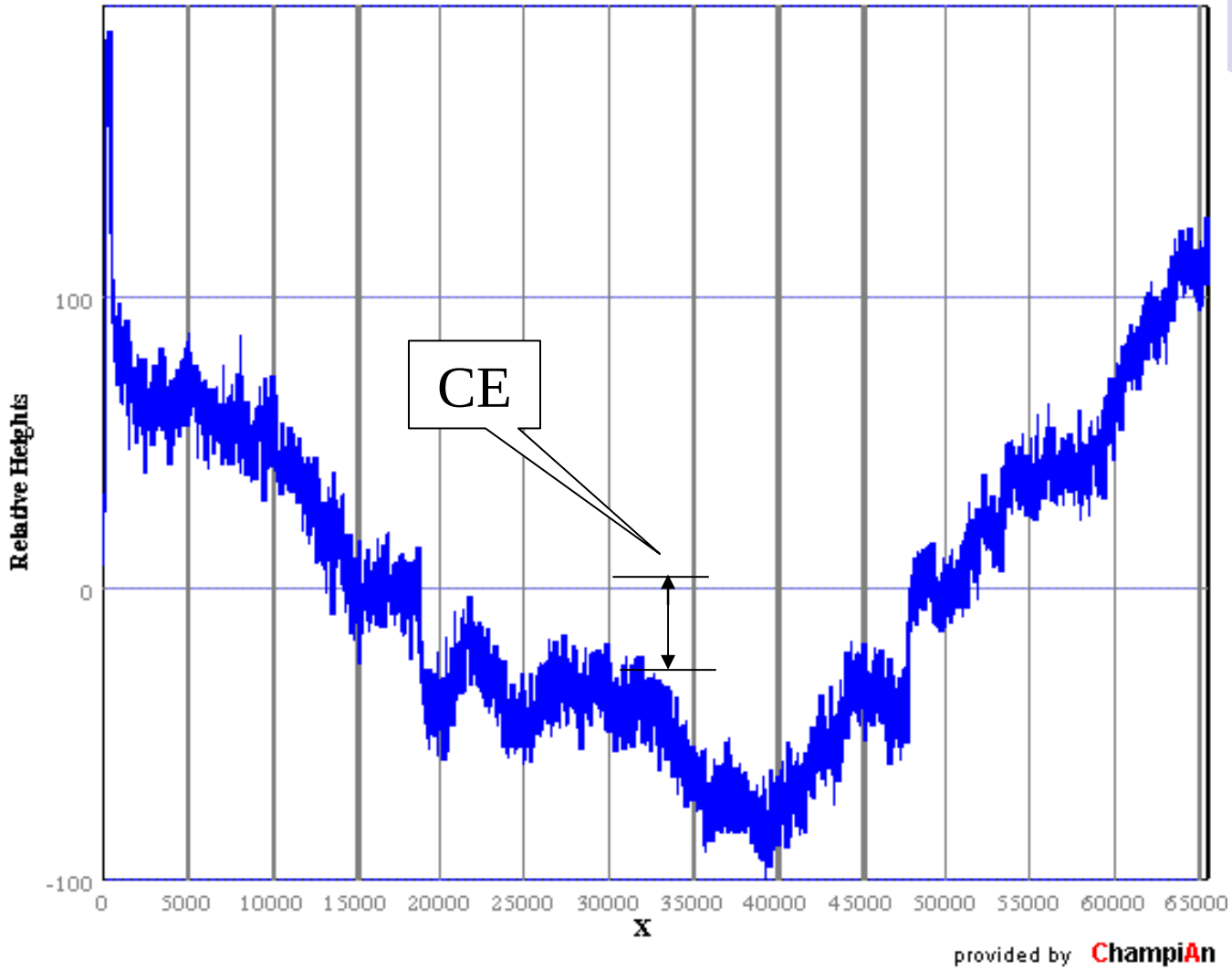
Line1Dish (Å)	Line2Dish (Å)	EOE (Å)	CE (Å)	Array Dish (Å)
58	63	134	173	30

Slurry 2



Line1Dish (Å)	Line2Dish (Å)	EOD (Å)	CE (Å)	Array Dish (Å)
121	133	0	76	165

Slurry 2



Line1Dish (Å)	Line2Dish (Å)	EOE (Å)	CE (Å)	Array Dish (Å)
-	-	-	34	31

Conclusions

- The NCP pads from Mipox performed well in comparison to the reference pad
- Further optimization of the process could lead to more favorable results
- Mipox NCP pads stand a very good chance to be used for commercial applications