

# Engineered Surface Finishing of HVOF Tungsten Carbide

PETEOS

HDP

Lo-K

TEOS

BPSG



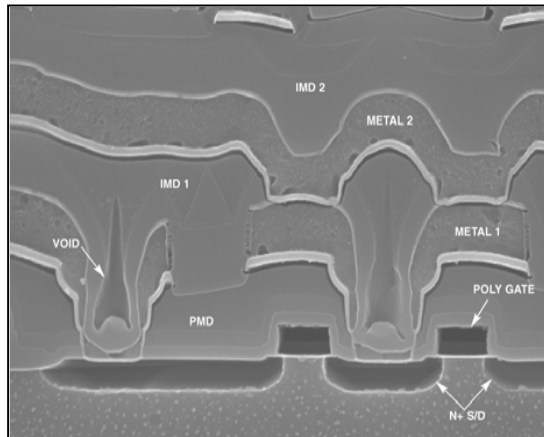
| Report Documentation Page                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                    |                                     |                                                                  | Form Approved<br>OMB No. 0704-0188                  |                                    |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|-------------------------------------|------------------------------------------------------------------|-----------------------------------------------------|------------------------------------|
| Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. |                                    |                                     |                                                                  |                                                     |                                    |
| 1. REPORT DATE<br><b>JAN 2006</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                    | 2. REPORT TYPE                      |                                                                  | 3. DATES COVERED<br><b>00-00-2006 to 00-00-2006</b> |                                    |
| 4. TITLE AND SUBTITLE<br><b>Engineered Surface Finishing of HVOF Tungsten Carbide</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                    |                                     |                                                                  | 5a. CONTRACT NUMBER                                 |                                    |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                    |                                     |                                                                  | 5b. GRANT NUMBER                                    |                                    |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                    |                                     |                                                                  | 5c. PROGRAM ELEMENT NUMBER                          |                                    |
| 6. AUTHOR(S)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                    |                                     |                                                                  | 5d. PROJECT NUMBER                                  |                                    |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                    |                                     |                                                                  | 5e. TASK NUMBER                                     |                                    |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                    |                                     |                                                                  | 5f. WORK UNIT NUMBER                                |                                    |
| 7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)<br><b>Cabot Microelectronics,870 N. Commons Drive,Aurora,IL,60504</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                    |                                     |                                                                  | 8. PERFORMING ORGANIZATION<br>REPORT NUMBER         |                                    |
| 9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                    |                                     |                                                                  | 10. SPONSOR/MONITOR'S ACRONYM(S)                    |                                    |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                    |                                     |                                                                  | 11. SPONSOR/MONITOR'S REPORT<br>NUMBER(S)           |                                    |
| 12. DISTRIBUTION/AVAILABILITY STATEMENT<br><b>Approved for public release; distribution unlimited</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                    |                                     |                                                                  |                                                     |                                    |
| 13. SUPPLEMENTARY NOTES<br><b>26th Replacement of Hard Chrome and Cadmium Plating Program Review Meeting, January 24-26, 2006, San Diego, CA. Sponsored by SERDP/ESTCP.</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                    |                                     |                                                                  |                                                     |                                    |
| 14. ABSTRACT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                    |                                     |                                                                  |                                                     |                                    |
| 15. SUBJECT TERMS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                    |                                     |                                                                  |                                                     |                                    |
| 16. SECURITY CLASSIFICATION OF:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                    |                                     | 17. LIMITATION OF<br>ABSTRACT<br><b>Same as<br/>Report (SAR)</b> | 18. NUMBER<br>OF PAGES<br><b>12</b>                 | 19a. NAME OF<br>RESPONSIBLE PERSON |
| a. REPORT<br><b>unclassified</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | b. ABSTRACT<br><b>unclassified</b> | c. THIS PAGE<br><b>unclassified</b> |                                                                  |                                                     |                                    |

# Introduction to Cabot Microelectronics

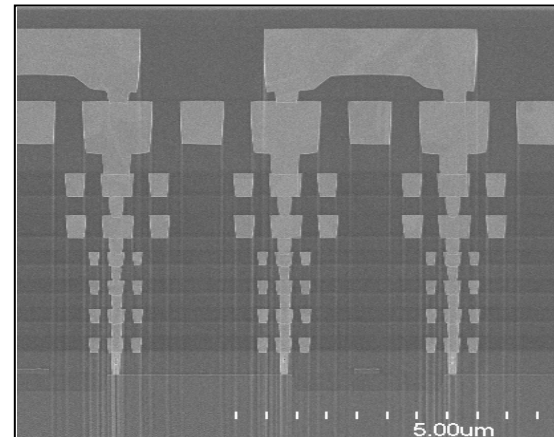
## Cabot Microelectronics' History

- ◆ 1983 – CMP technology invented
- ◆ 1990 – Cabot Microelectronics established a division of Cabot Corporation
- ◆ 2000 – Initial Public Offering and Spin-off to a fully independent company

## Chemical Mechanical Planarization (CMP)



Non-planarized IC product



Planarized IC product



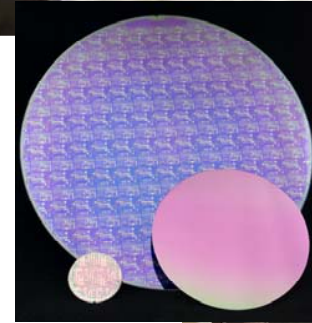


# CMC's Operations Worldwide



# Cabot Microelectronics

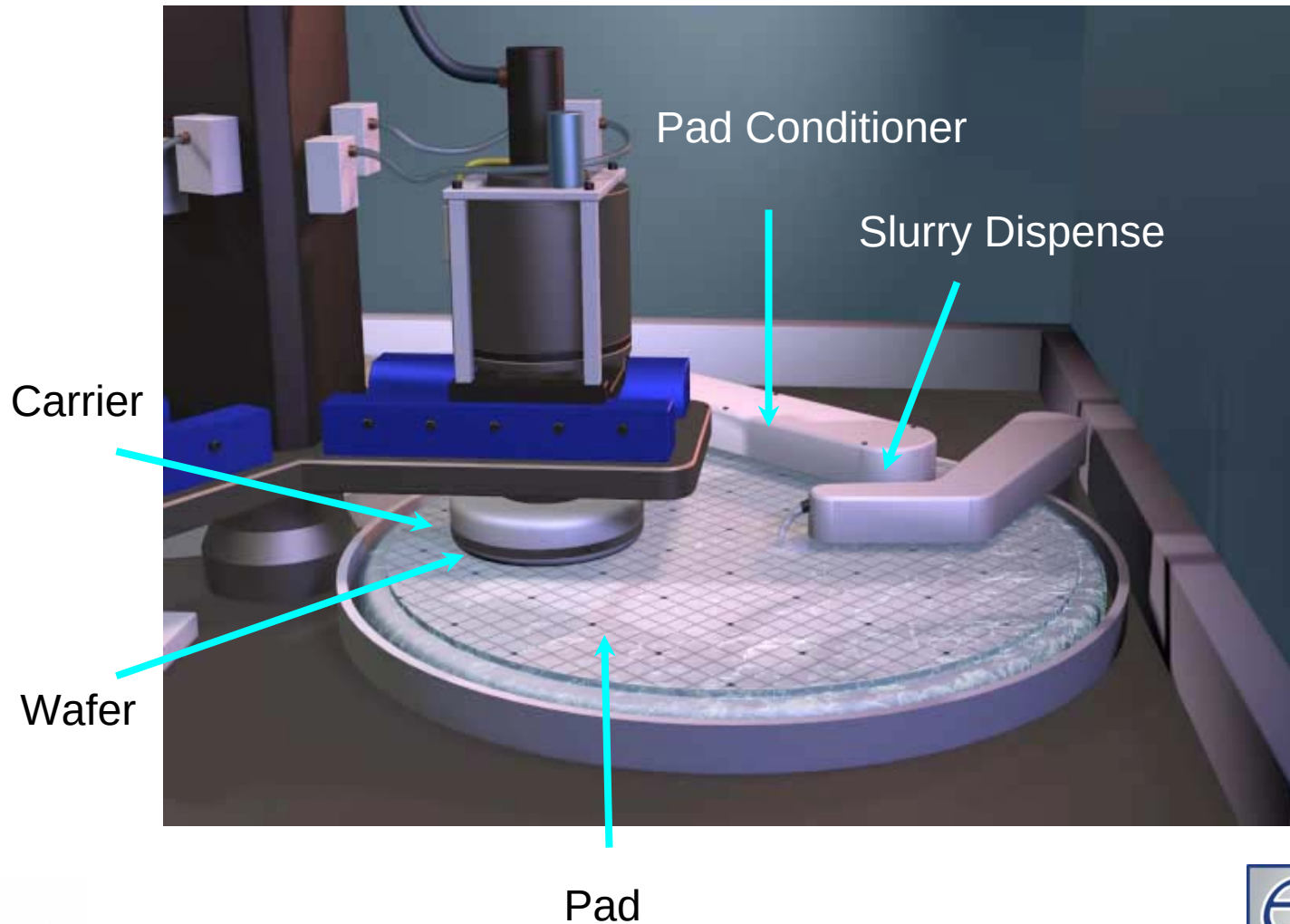
- ◆ World Leader in Chemical Mechanical Polishing (CMP) for semiconductor manufacturing
- ◆ Substantial investment in fundamental science of surface finishing and formulation design
- ◆ All facilities have ISO 9001 and ISO 14001 registration
- ◆ Solutions for Si, SiO<sub>2</sub>, W, Cu, Al, Ni, Ti, TiN, Si<sub>3</sub>N<sub>4</sub>, Ta, TaN, Ru, Pt, Ir



# Chemical Mechanical Polishing

- ◆ Process using slurry (chemical and mechanical), pad (mechanical) and equipment to produce a surface with the desired attributes.
- ◆ Slurry – colloidally stable, aqueous solution of ceramic abrasive particles and chemistry.
- ◆ Pad – Working surface, generally polymeric.
- ◆ Equipment – means of combining the slurry, pad and process parameters to provide consistent results.

# CMP Polisher





# Why CMP?

## Advantages:

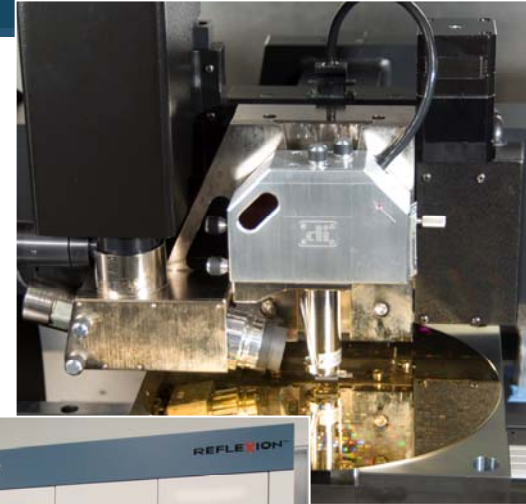
- ◆ Process Simplification
  - ◆ Can eliminate need for separate grind, hone and lapping steps
  - ◆ Could be combined with other process steps to improve overall process efficiency
- ◆ Does not create sub-surface damage to material
- ◆ Ability to polish multiple materials simultaneously
- ◆ Overall range of surface finish

## Drawbacks:

- ◆ Time
- ◆ Equipment compatibility



# Engineered Surface Finishes

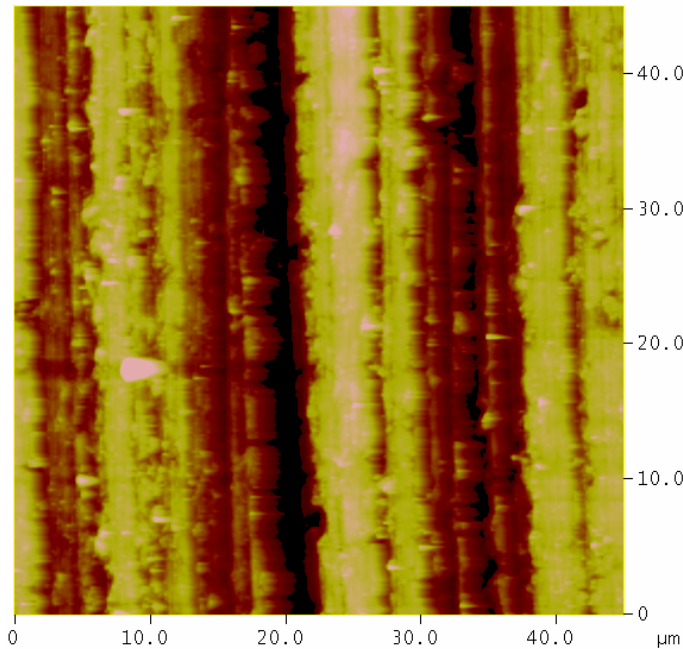


## Solutions for

- ◆ Industrial & Medical applications
- ◆ Optics
- ◆ Optoelectronic (FPD, microelectronics, photovoltaic, LED)

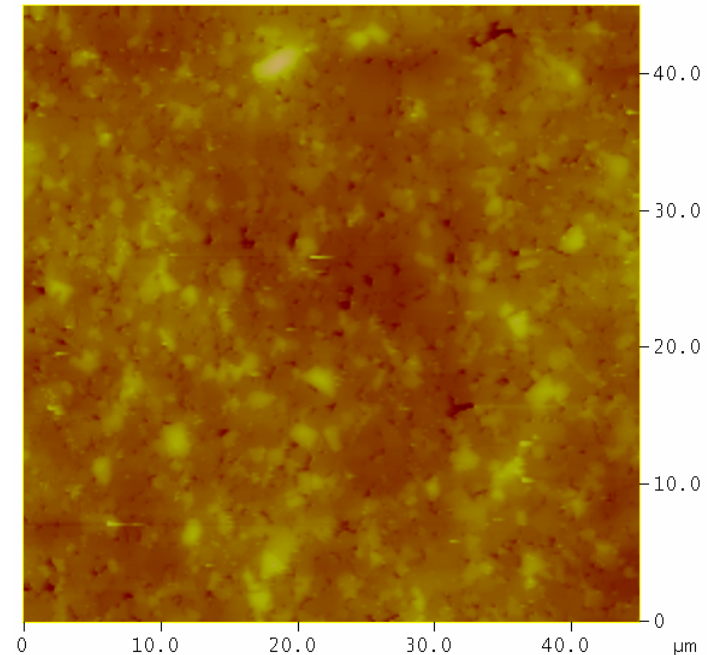


# Tungsten Carbide Before & After Polishing



Before Polishing

Surface Roughness (Ra) = 94.5 nm



After Polishing

Surface Roughness (Ra) = 16.3 nm

**Results:** Improved wear, cut quality, service life, less friction

# CMP Polished HVOF Tungsten Carbide



Mag: 20.2 X

Mode: PSI

## Surface Data

Date: 05/06/2005

Time: 13:39:12

### Surface Statistics:

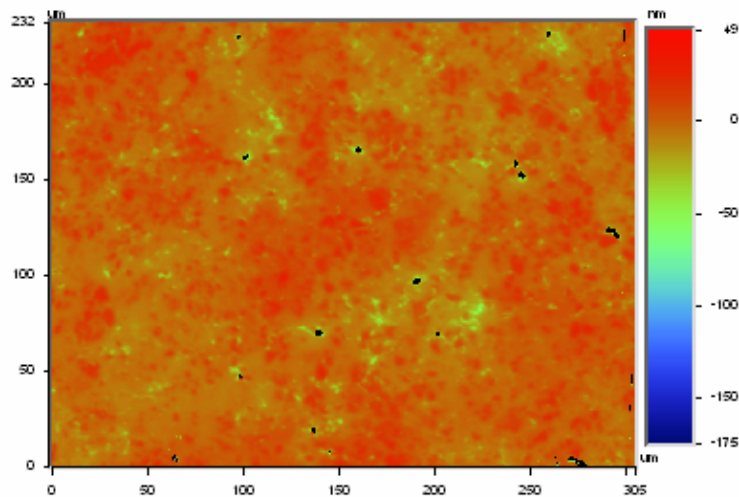
Ra: 5.96 nm  
Rq: 7.81 nm  
Rz: 128.76 nm  
Rt: 223.90 nm

### Set-up Parameters:

Size: 736 X 480  
Sampling: 415.64 nm

### Processed Options:

Terms Removed:  
Tilt  
Filtering:  
None



Title:

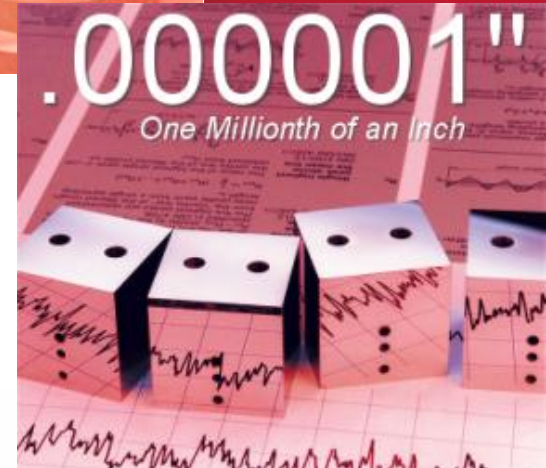
Note:

- Part courtesy of J. Devereaux, Naval Depot



# Additional Capabilities

- ◆ State-of-the-Art Polishing
  - ◆  $\lambda/20$  Precision
  - ◆ Reference Flats
- ◆ Diamond Machining
- ◆ Custom Lapping
- ◆ Submicron Finishing
- ◆ Prototyping
- ◆ Contract Manufacturing
- ◆ Cleanroom/Metrology Services



**Surface Finishes**

[www.surfacefinishes.com](http://www.surfacefinishes.com)



# Sample List of Materials

## Existing Capability

- ◆ Tungsten Carbide
- ◆ Aluminum
- ◆ Stainless Steel
- ◆ Copper
- ◆ Molybdenum
- ◆ Cobalt Chrome
- ◆ Aluminum Nitride
- ◆ Polysilicon
- ◆ Silicon Nitride
- ◆ Silicon Dioxide
- ◆ Tungsten

## Under Development

- ◆ Fused Silica
- ◆ Fused Quartz
- ◆ ALON
- ◆ Silicon Carbide
- ◆ Sapphire
- ◆ ZnSe
- ◆ Germanium