Controlled Erosion with Micro-Abrasive Blasting:

How Improved Technology is Solving New Machining Challenges

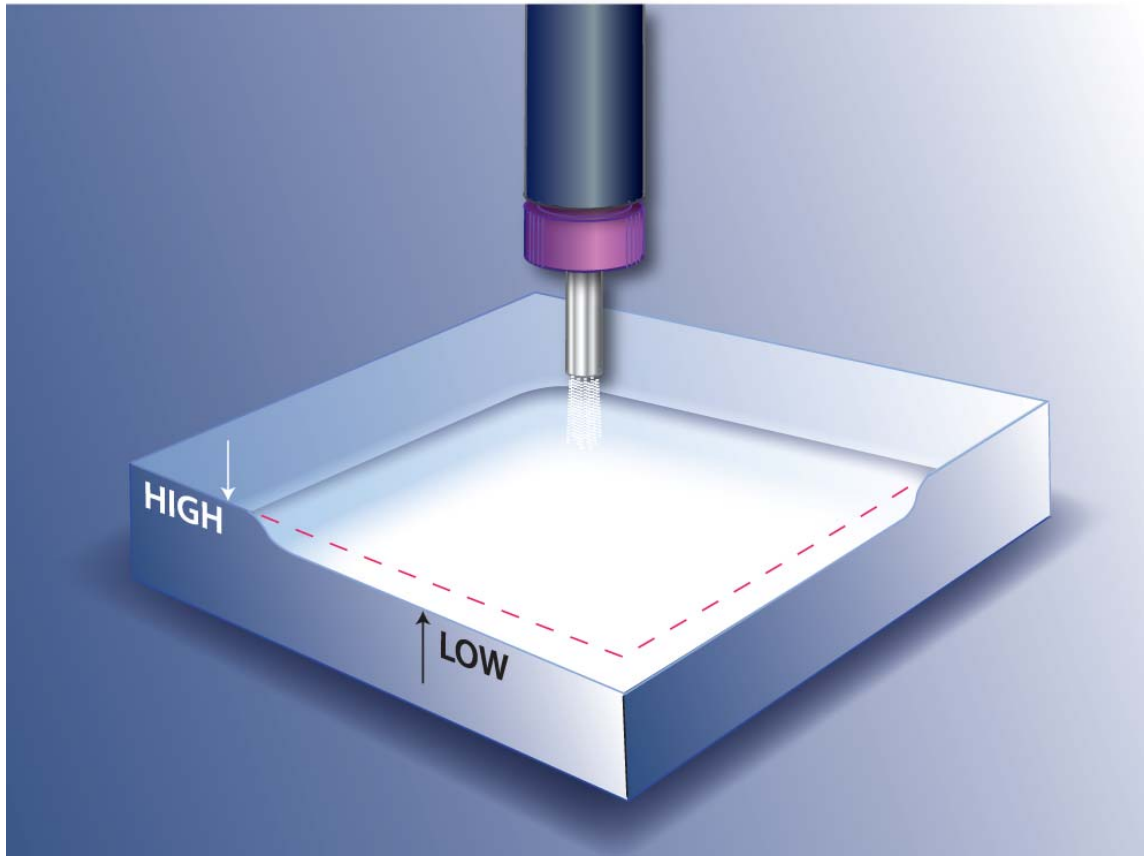
COMCO INC.

Overview

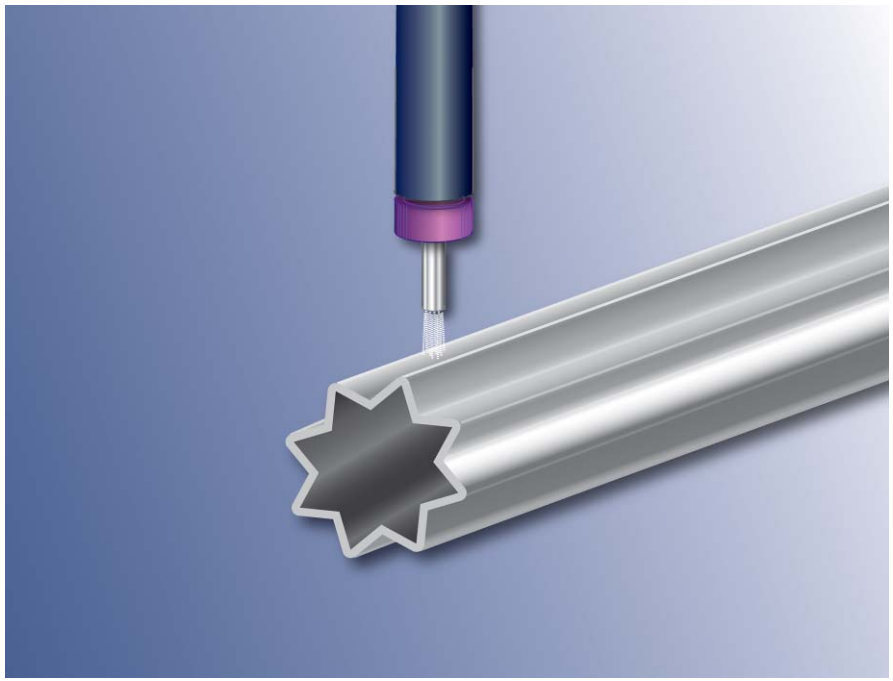
- Who is Comco?
- What is Controlled Erosion?

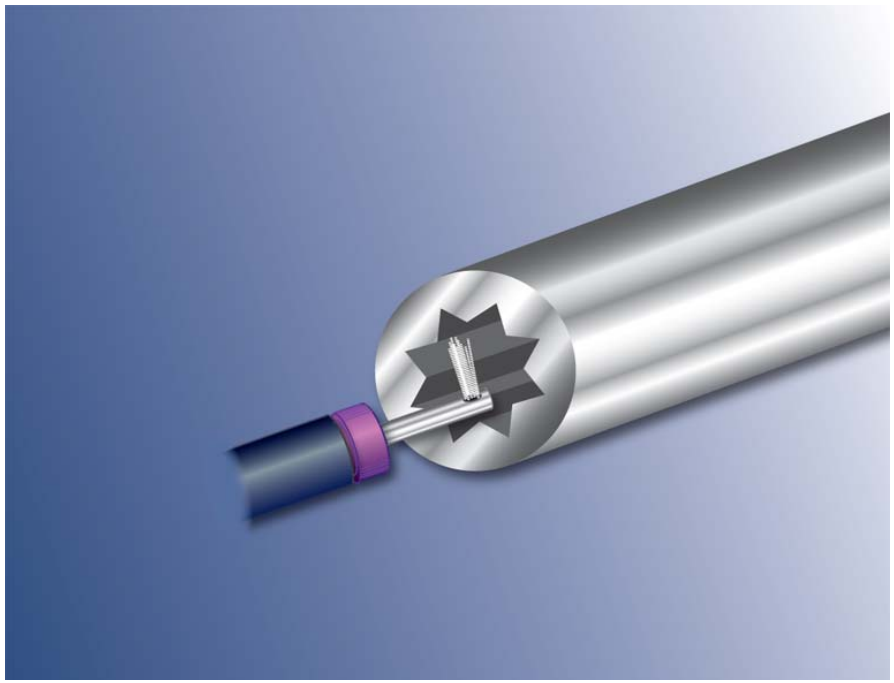
- Fundamentals of creation.
- How to measure.
- How to control accuracy and repeatability.

What is Controlled Erosion?



Examples of Controlled Erosion





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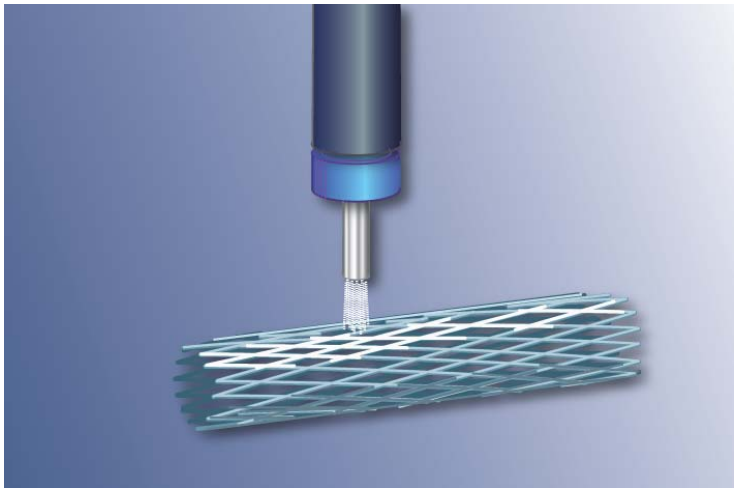

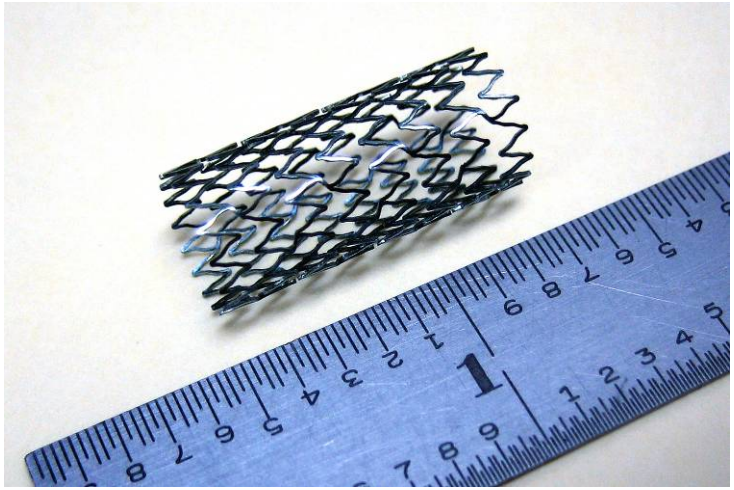

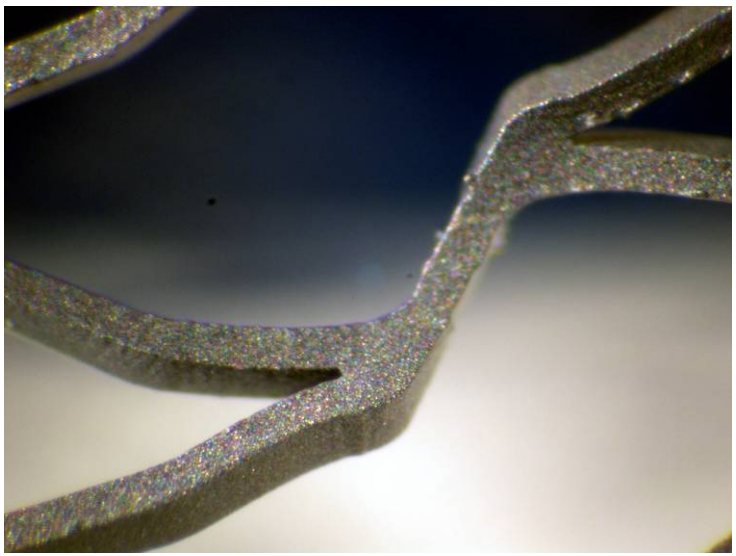

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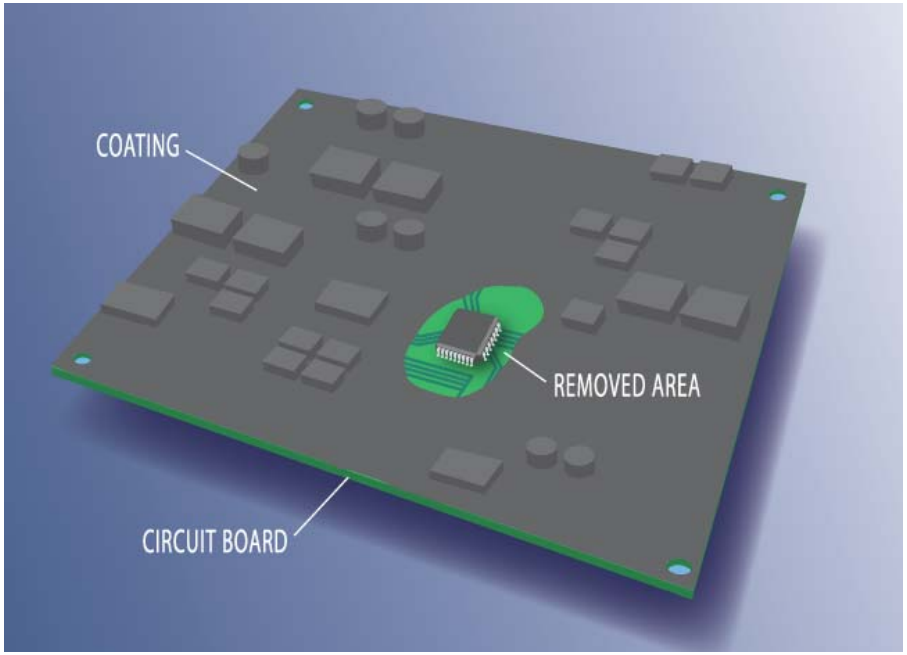

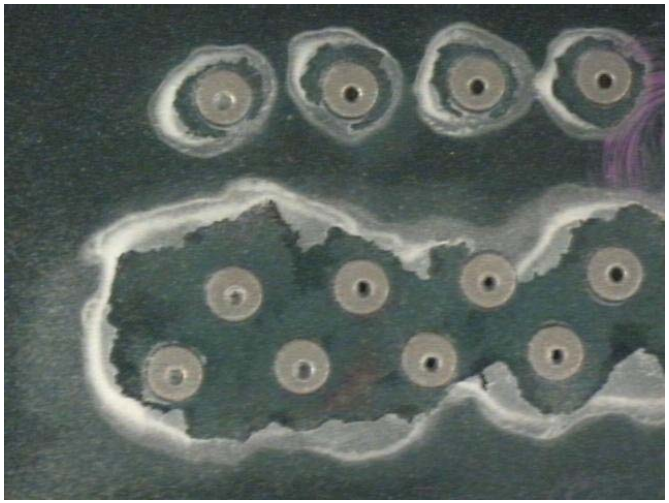

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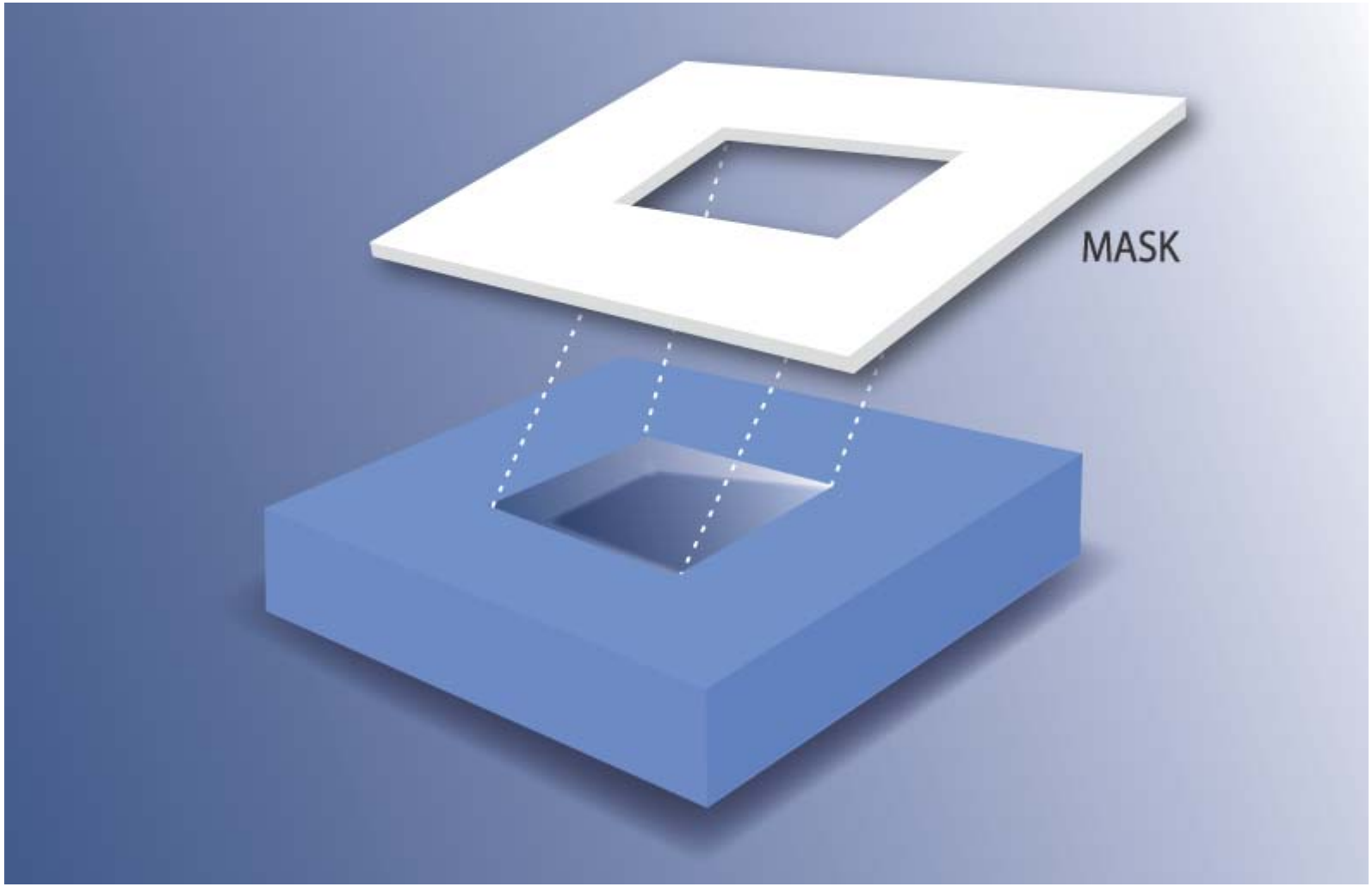
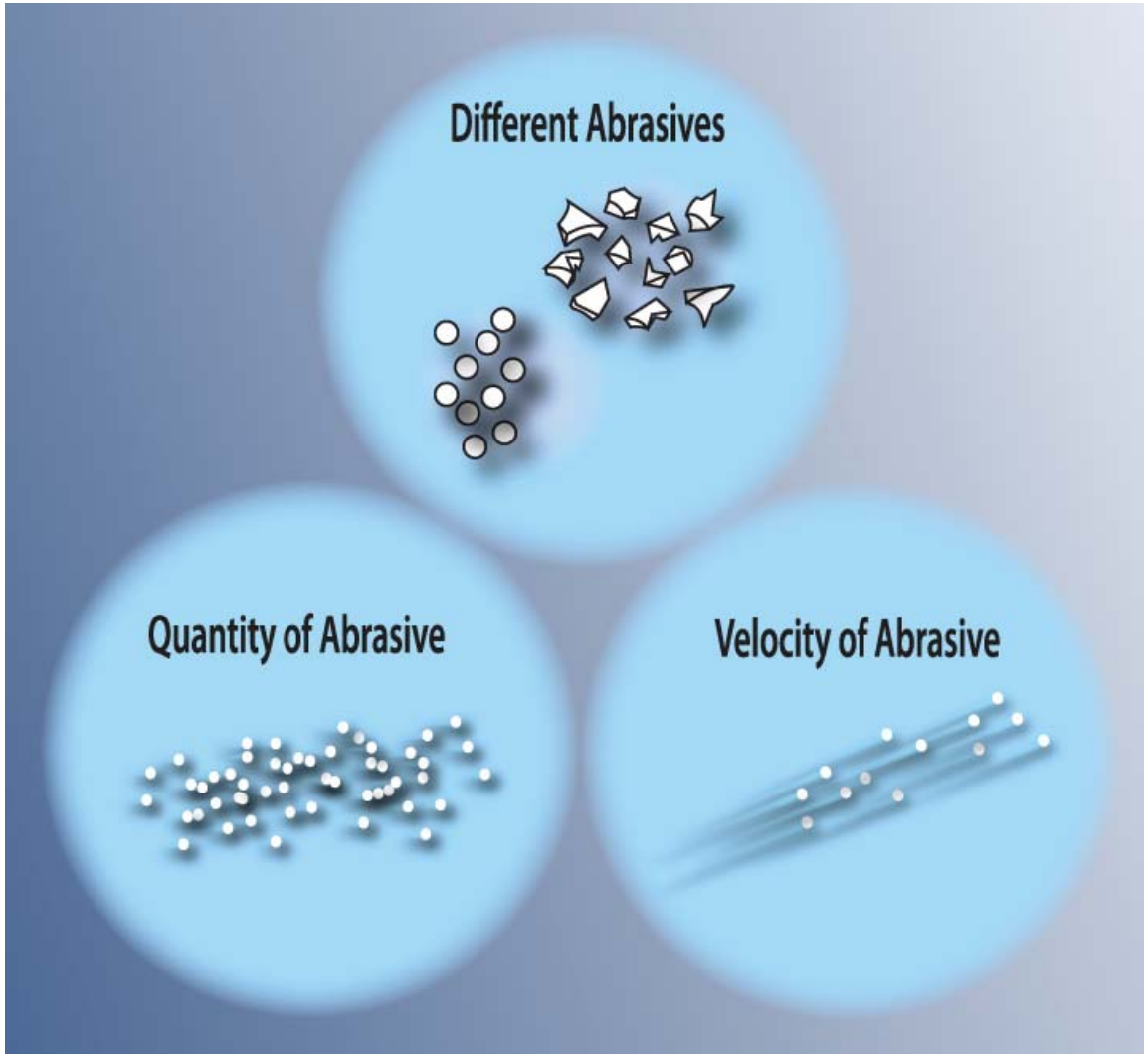
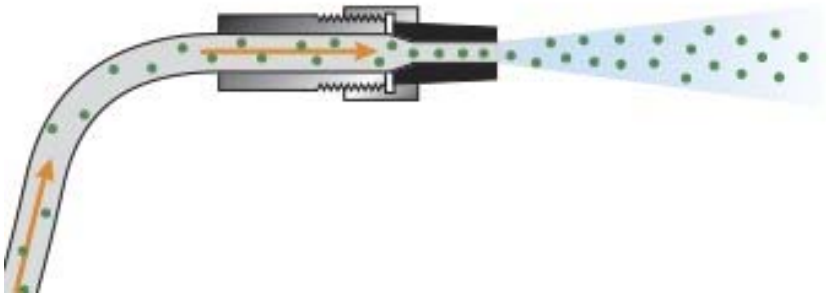


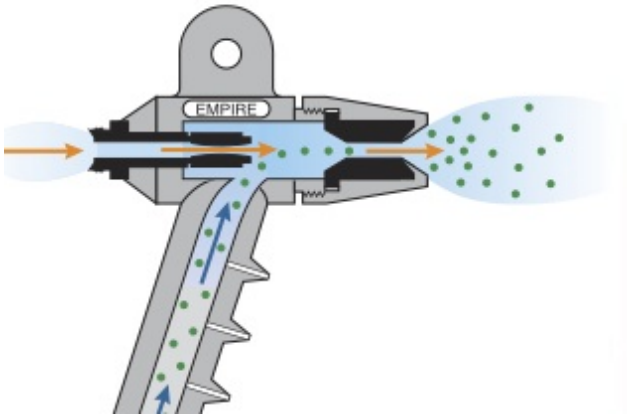
Fundamentals of Controlled Erosion

The Abrasive Stream



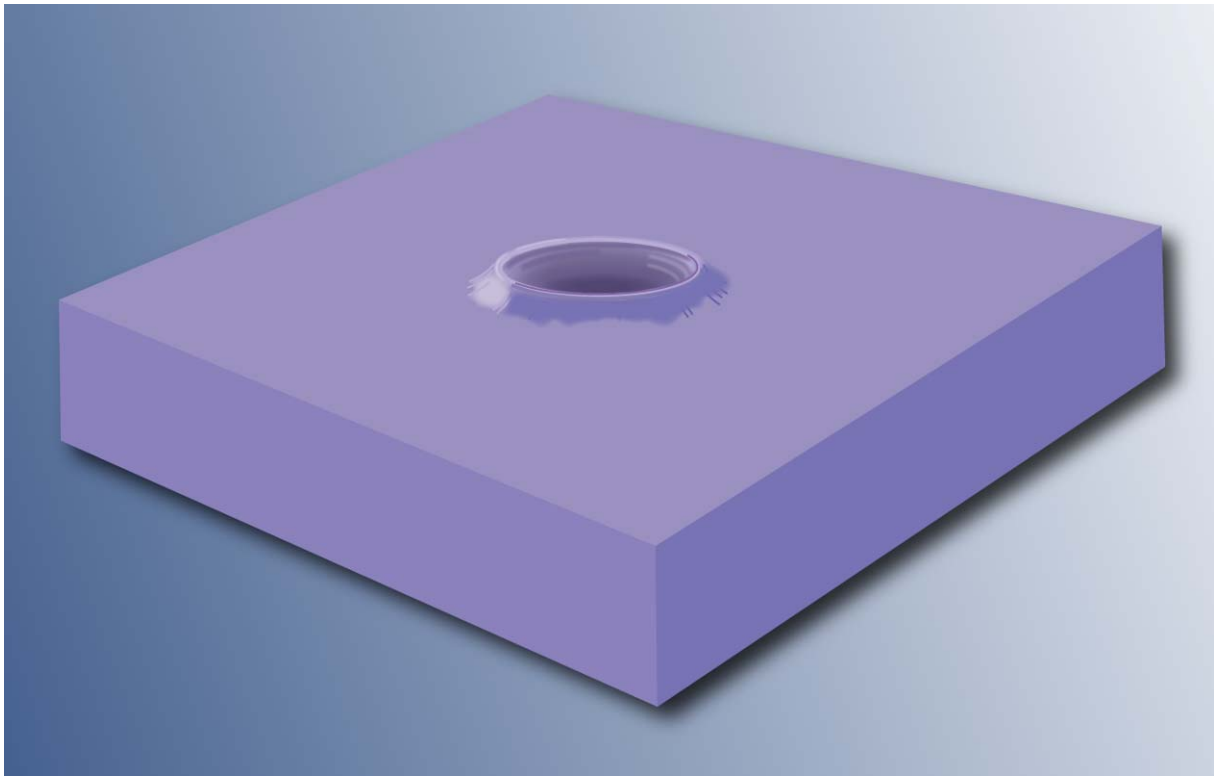
Pressure vs. Suction





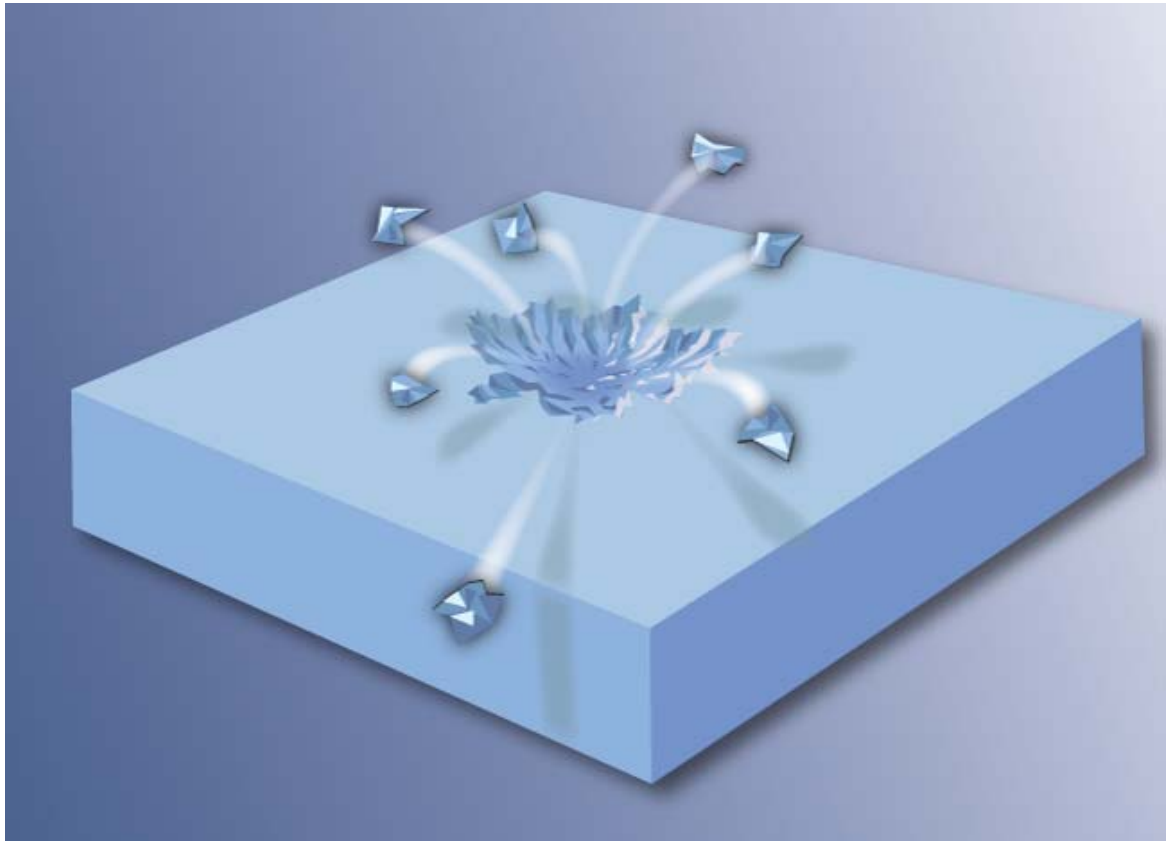
Ductile Materials

- Material displaces
- Dent size (Ra) depends on abrasive size and velocity
- Erosion slow
- Soft metals, plastics, elastomers



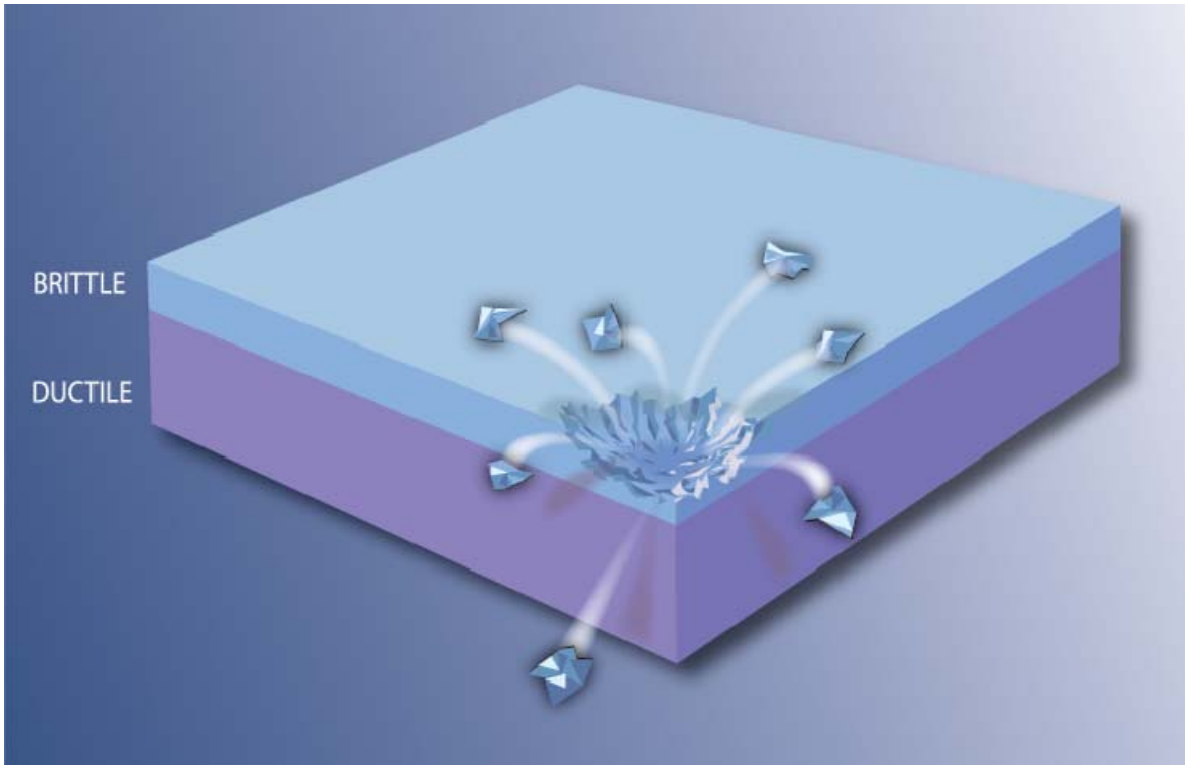
Brittle Materials

- Material shatters
- Pit size depends on material properties, plus abrasive size and velocity
- Erosion fast
- Ceramics, oxides, hardened surfaces

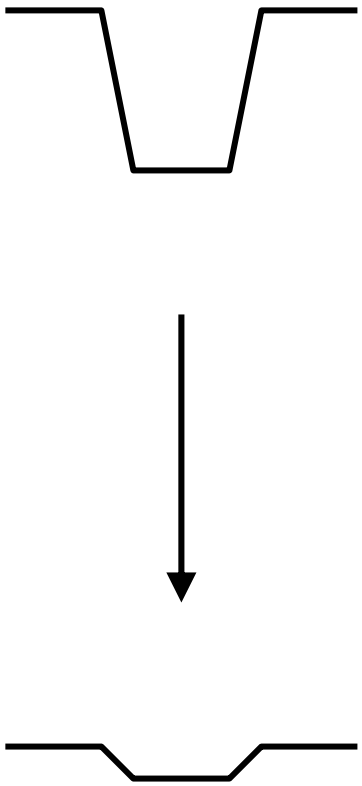


Layered Materials

- Usual goal is to remove top layer without affecting bottom layer
- Abrasive selection is key



How to Measure

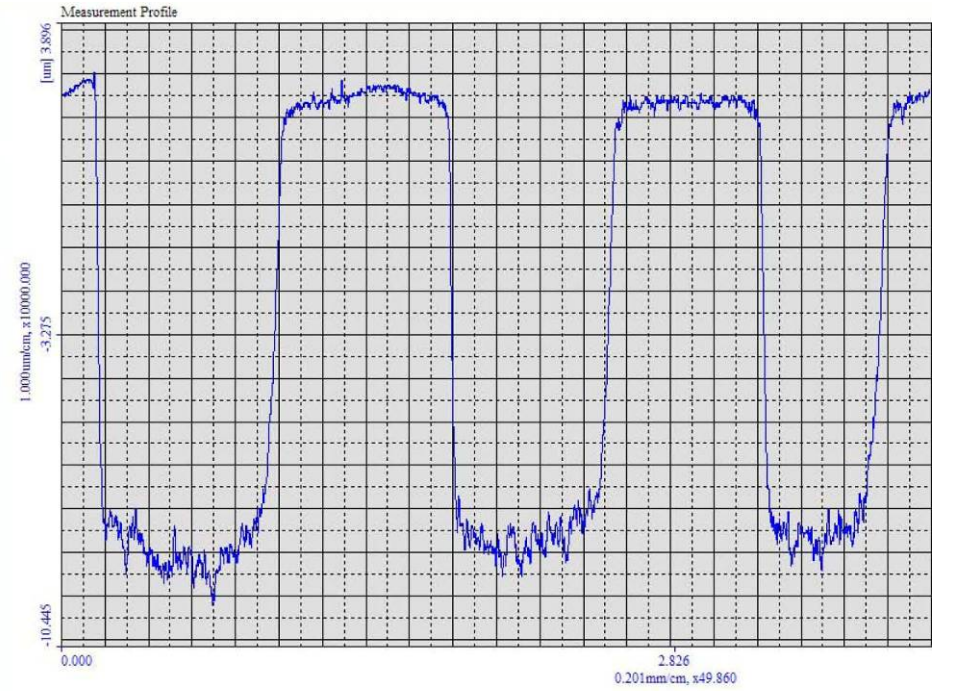


- Visual confirmation
- Calipers or micrometer
- Gauges
- Weight loss
- Stylus profilometer
- Laser triangulation
- Microscope / Interferometer

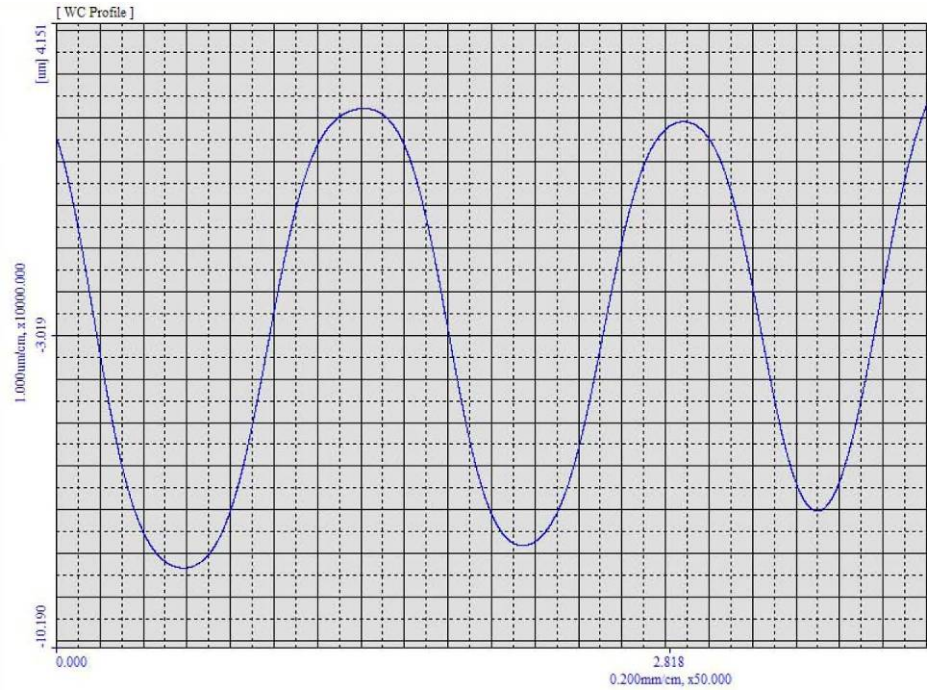
Profilometer

- Comco uses Mitutoyo SJ-201 with Surfpak-SJ software
- 2um tip radius with 0.75 mN downforce
- Manufacturer claims 10 nm resolution
- 1000 nm real-world depth measuring
- $2500 for profilometer and $2500 for software

Profilometer

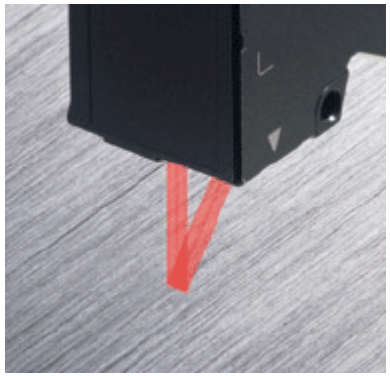


Unfiltered measurement profile



Profile filtered to remove higher frequencies

Laser Triangulation

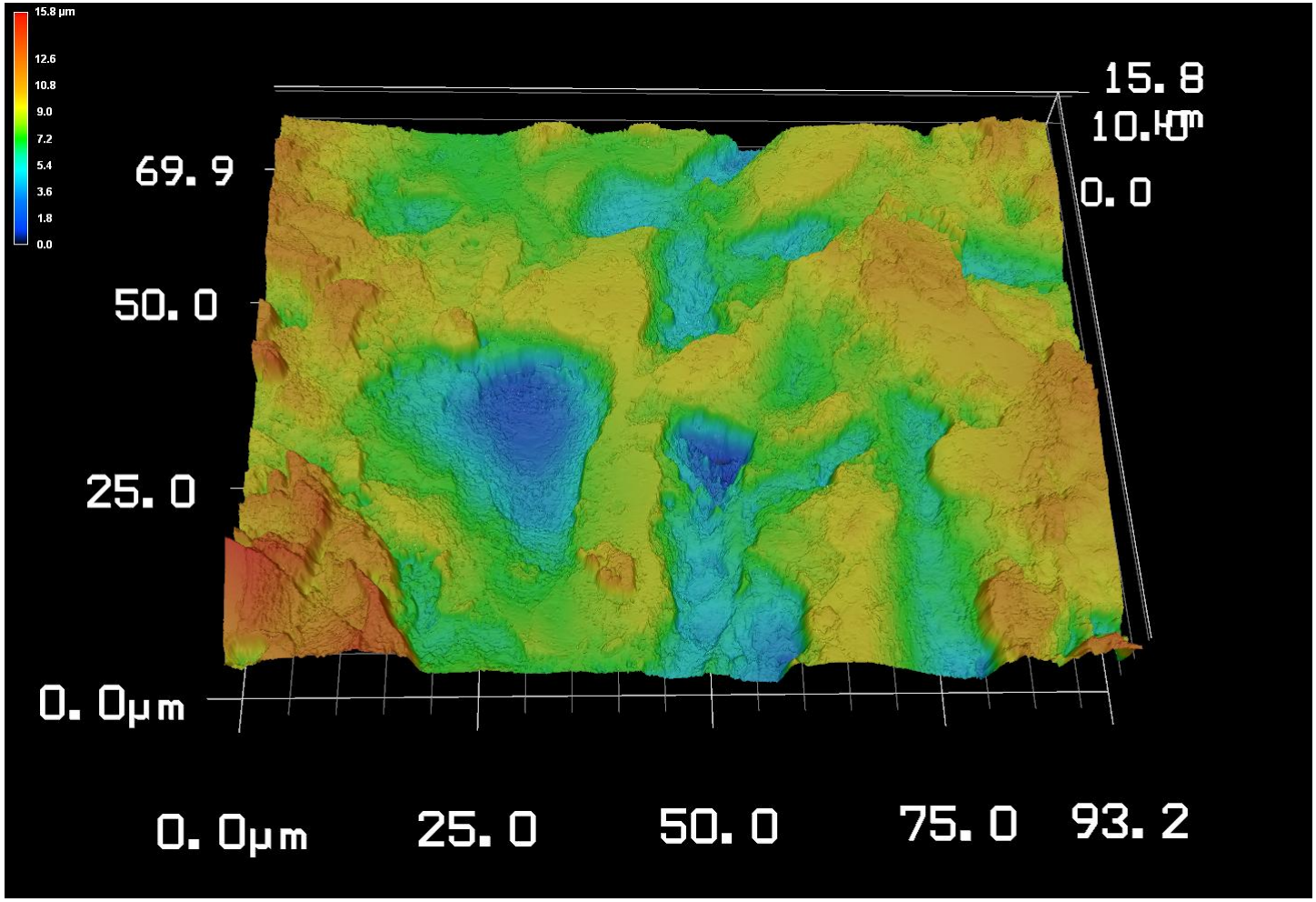


- Comco uses Keyence LK-H008W sensor and LK-G5001 controller
- 20um x 550um beam spot size
- Manufacturer claims 5 nm resolution
- 100 nm real-world depth measuring
- $7000 for sensor and $3000 for controller

Microscope / Interferometer

- Comco has explored Keyence VK-9700 and Zygo NewView 7000 series
- Manufacturers claim better than .1 nm resolution
- Typical system cost around $100,000

Microscope / Interferometer



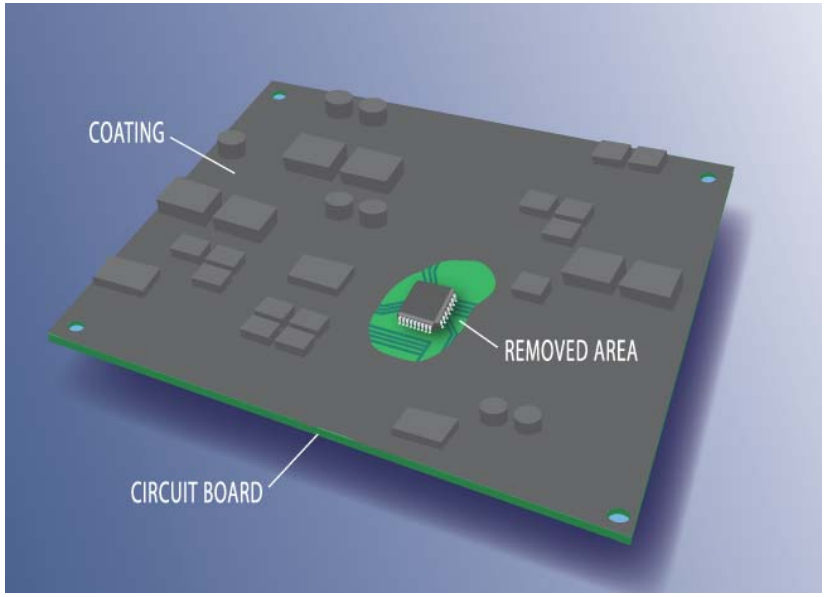
How to Control Erosion Depth

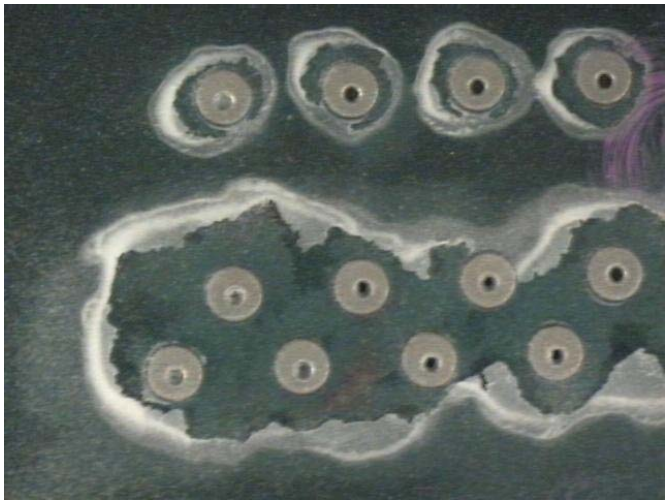
What does the application require?

- Depth
  - Typical depths 0.5um to 10mm
  - Typical tolerances ±0.5um to ±0.5mm
- Surface Roughness
  - Typical roughness 0.1um Ra to 2.0um Ra
  - Typical tolerances 5% of Ra
- Delineation
  - Sharp transition from blasted to unblasted may require a mask

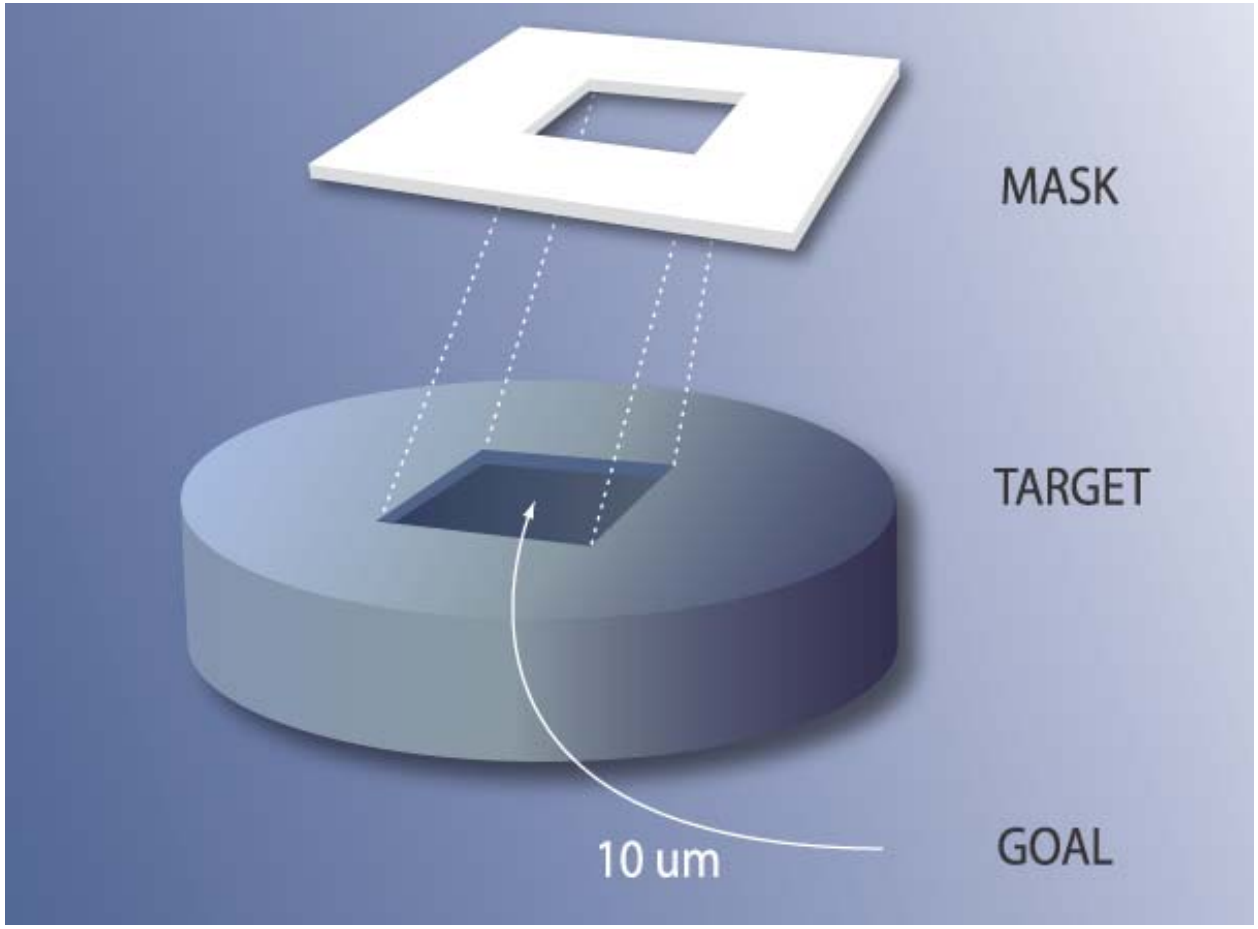
Visual Control

- Effective for coating removal applications
- Effective in manual applications
- Select abrasive that preferentially erodes top material and does not as readily affect underlying material



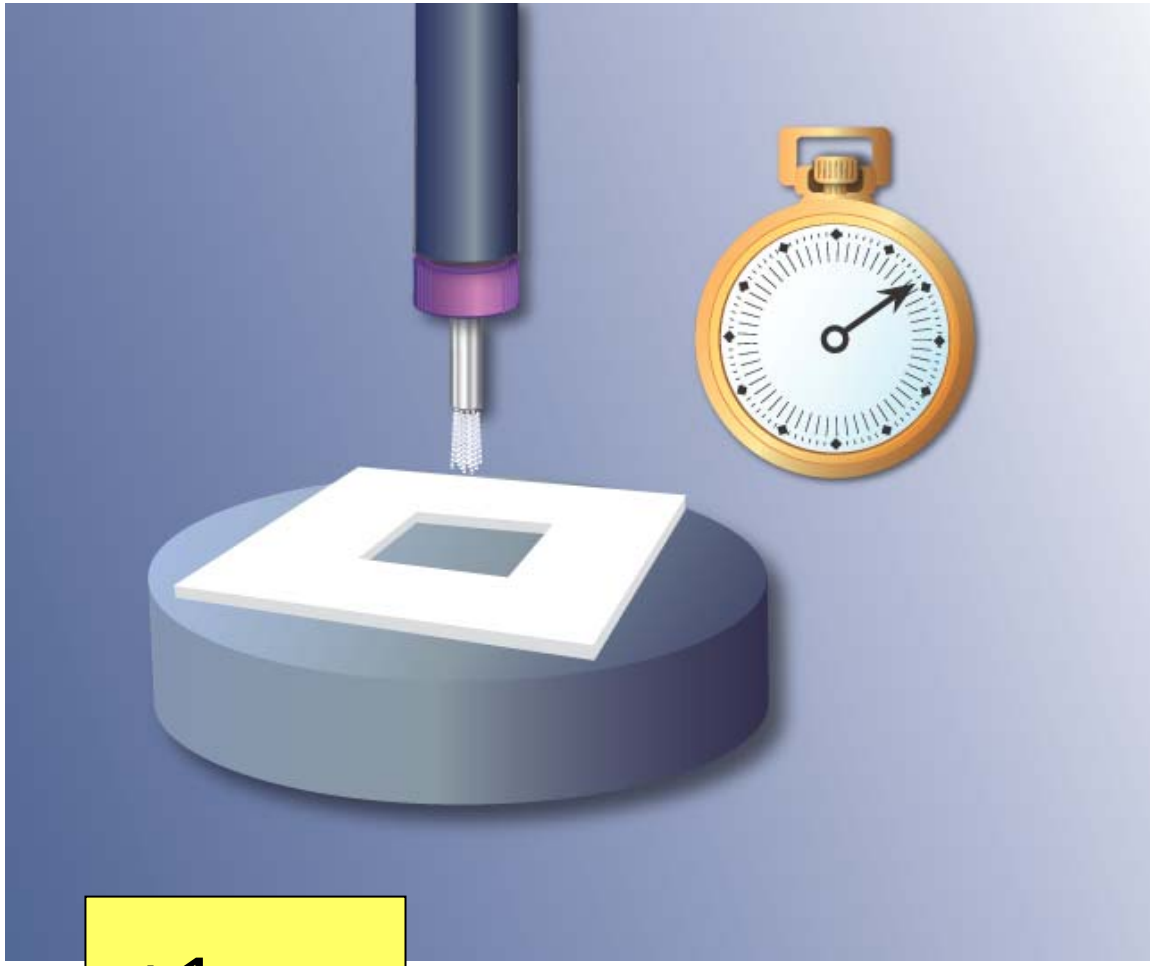


Automatic Control



Timed Blast

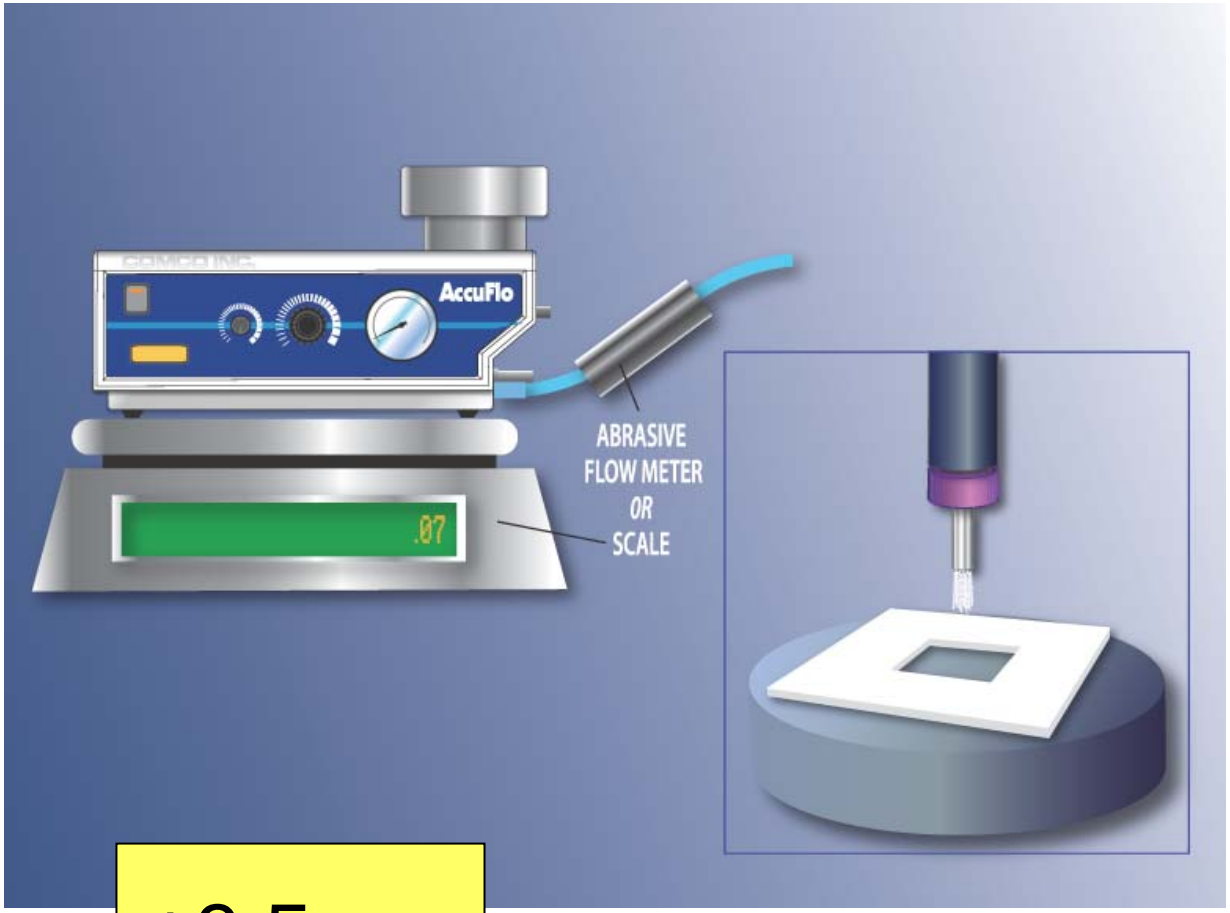
- Experiment with different blast durations
- Measure resultant depths
- Interpolate & experiment to find required duration
- Abrasive, velocity, and quantity consistency critical to depth repeatability
- Target part must be very consistent



±1 um

Real-Time Abrasive Output

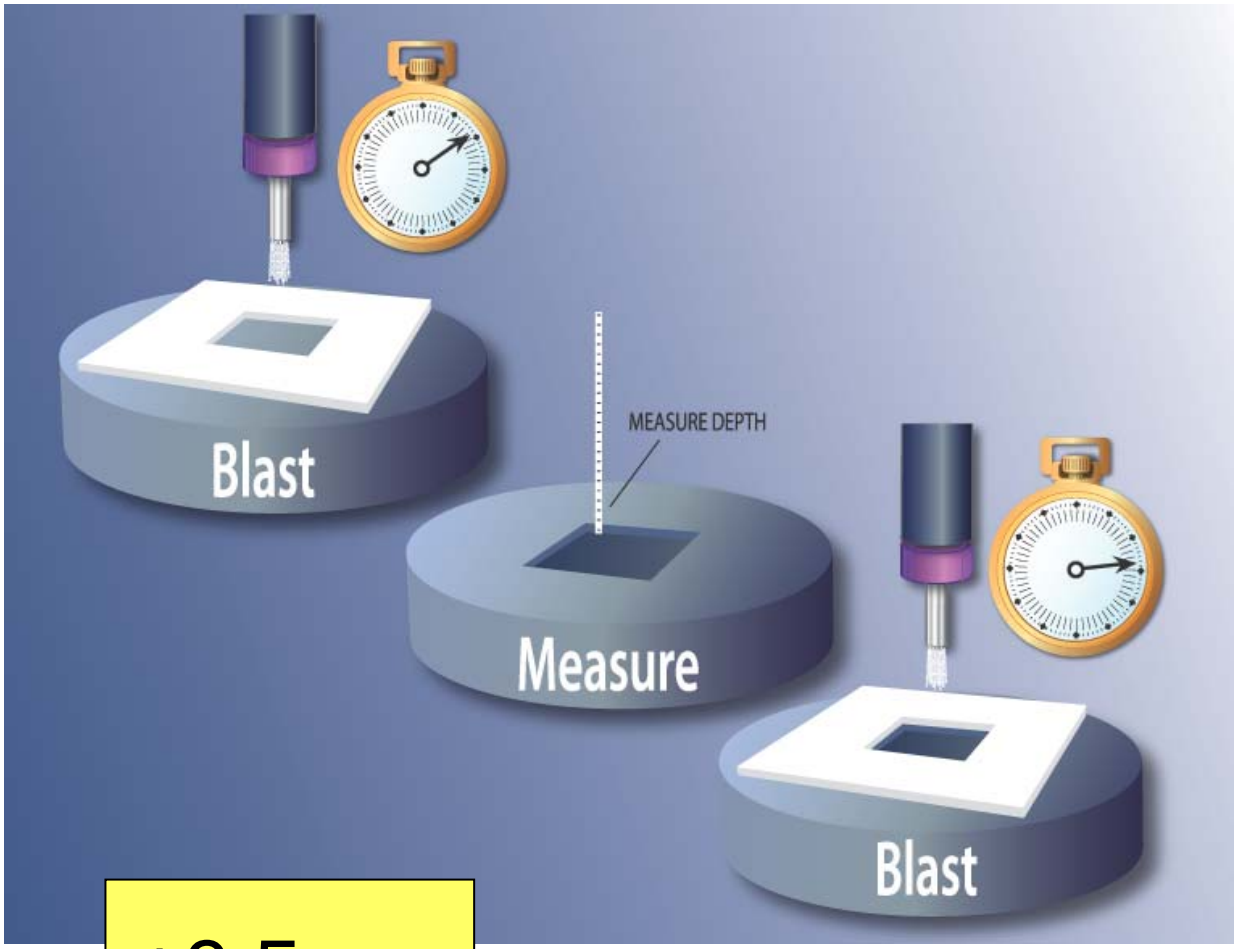
- Blast part until a predetermined amount of abrasive has been output
- Abrasive used on part is a good predictor of depth
- Abrasive, velocity, and quantity consistency critical to depth repeatability
- Target part must be very consistent



±0.5 um

Blast – Measure – Blast

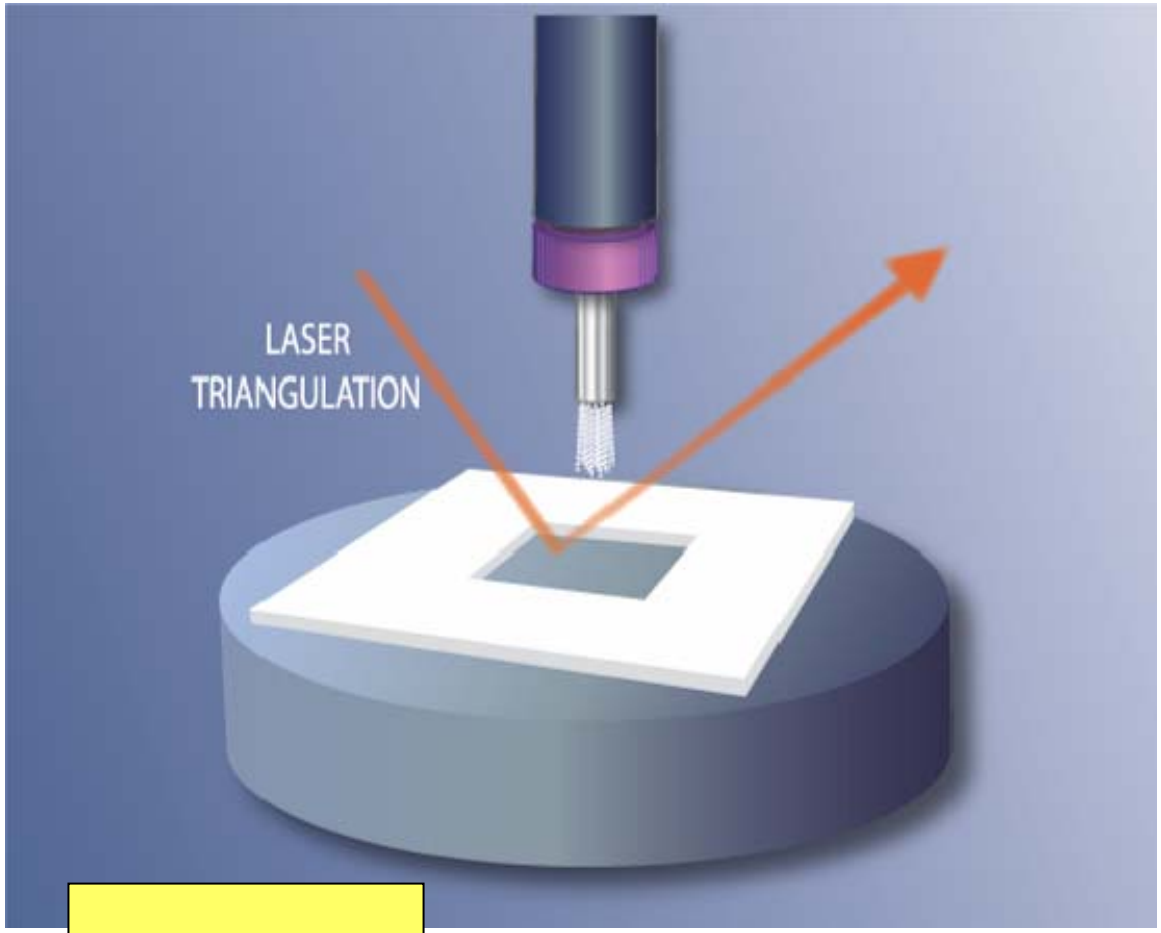
- Similar to timed blast, but can accommodate some input variability
- Inconvenient to need to interrupt process for measurement
- Risk of mask not being properly aligned when reinstalled



±0.5 um

Real-Time Depth Measurement

- Triangulation laser sensor compatible with blast environment
- Accommodates large range of input variability
- Part can vary in erosive resistance
- Blast consistency not as critical



±0.1 um

Conclusion

- Fundamentals of creation
  - Blast stream requirements
  - Target surface types
- How to measure
  - Various measurement devices
- How to control accuracy and repeatability
  - Open and closed loop methods