Controlled Erosion with Micro-Abrasive Blasting: How Improved Technology is Solving New Machining Challenges
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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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
• 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