# APPENDIX B

# MARKING DATA SHEETS

## MARKING DATA SHEETS

## DPM MACHINE DATA SHEET

## DPM PROCESS DATA SHEETS

A1A-01
A1A-02
A1A-03
A1A-04
A1A-05 - A1A-16 : A2A-01 - A2A-06

S1A-01
S1A-02
S1A-03
S1A-04
S1A-05 - S1A-16 : S2A-01 - S2A-06

S1B-01
S1B-02
S1B-03
S1B-04
S1B-05 - S1B-16 : S2B-01 - S2B-06

# DPM MACHINE DATA SHEET

| DPM Process | DPM Machine Data | |
|---|---|---|
| 1 - Dot Peen | Marking Machine: | TMP 6000 |
| | Manufacturer: | Telesis |
| | Model Number: | TMC 1000 Controller |
| | Computer: | Gateway 2000 |
| | Software: | 1.00C |
| 2 - LaserShot™ Peen | Marking Machine: | Pulsed Laser |
| | Manufacturer: | LLNL/MIC |
| | Model Number: | N/A |
| | Computer: | PC Controller |
| | Software: | LabVIEW |
| 3 - Micro-Mill | Marking Machine: | SAM 5 |
| | Manufacturer: | Servo Products |
| | Model Number: | N/A |
| | Computer: | N/A |
| | Software: | LCD-NT |
| 4 - Laser Bond | Marking Machine: | Nd:YAG Laser |
| | Manufacturer: | Rofin-Sinar |
| | Model Number: | RSY 90Q |
| | Computer: | Siemens Nixdorf PCD-5H |
| | Software: | LWB Version 3.9 |
| 5 - Laser Etch | Marking Machine: | Nd:YAG Laser |
| | Manufacturer: | Rofin-Sinar |
| | Model Number: | RSY 90Q |
| | Computer: | Siemens Nixdorf PCD-5H |
| | Software: | LWB Version 3.9 |
| 6 - Gas Assist Laser Etch (GALE) | Marking Machine: | Vector Mark |
| | Manufacturer: | Haas |
| | Model Number: | D-78713 |
| | Computer: | Belinea |
| | Software: | WinMark |
| 7 - Laser Engrave | Marking Machine: | Nd:YAG Laser |
| | Manufacturer: | Rofin-Sinar |
| | Model Number: | RSY 90Q |
| | Computer: | Siemens Nixdorf PCD-5H |
| | Software: | LWB Version 3.9 |
| 8 - Laser Induce Surface Improvement (LISI) | Marking Machine: | Diode Pumped |
| | Manufacturer: | Trump |
| | Model Number: | 5V 9803 |
| | Computer: | Windows PC |
| | Software: | WinMark |
| 9 - Vibropeen | Marking Machine: | Vibropeen Pencil |
| | Manufacturer: | Chicago Phenmatic |
| | Model Number: | 4084A101 |
| 10 - Impression Stamp | Marking Machine: | Impression Stamp / Mallet |
| | Manufacturer: | N/A |
| | Model Number: | N/A |

Comments:

1-Dot Peen: Marked by SRC.
2-LaserShot™ Peen: Marked by LLNL.
3-Micro-Mill: Marked by SP.
4-Laser Bond: Marked by SRC.
5-Laser Etch: Marked by SRC.
6-GALE: Marked by UTSI.
7-Laser Engrave: Marked by SRC.
8-LISI: Marked by UTSI.
9-Vibropeen: Marked by ALGLE Program.
10-Impression Stamp: Marked by ALGLE Program.

| Prepared: SLM | Checked: DLR | Date: 3/29/01 |
|---|---|---|

# DPM PROCESS DATA SHEET
## COUPON: A1A-01

| DPM Process | DPM Process Data | Mark 1 | Mark 2 | Mark 3 | Mark 4 | Mark 5 | Mark 6 |
|---|---|---|---|---|---|---|---|
| 1 - Dot Peen | Stylus Configuration: | 30° | 30° | 30° | 30° | 30° | 30° |
| | Pressure Setting: | 60 psi | 60 psi | 60 psi | 60 psi | 60 psi | 60 psi |
| | Stylus to Substrate Gap: | 0.375 in | 0.375 in | 0.375 in | 0.375 in | 0.375 in | 0.375 in |
| | Cell Spacing: | 0.02 in | 0.019 in | 0.021 in | 0.0195 in | 0.0215 in | 0.022 in |
| | Total Time to Mark: | 1 min | 1 min | 1 min | 1 min | 1 min | 1 min |
| | Mark Grade: | B | B | B | B | B | B |
| 2 - LaserShot™ Peen | Fluence: | 120 J/cm2 | 120 J/cm2 | 120 J/cm2 | 120 J/cm2 | 120 J/cm2 | |
| | Pulse Width: | 20 ns | 20 ns | 20 ns | 20 ns | 20 ns | |
| | Wavelength: | 1053 nm | 1053 nm | 1053 nm | 1053 nm | 1053 nm | |
| | Rep Rate: | 1 Hz to 6 Hz | 1 Hz to 6 Hz | 1 Hz to 6 Hz | 1 Hz to 6 Hz | 1 Hz to 6 Hz | |
| | Mark Size: | 8 mm | 8 mm | 8 mm | 8 mm | 8 mm | |
| | Cell Size: | 0.57 mm | 0.57 mm | 0.57mm | 0.57mm | 0.57mm | |
| | Total Time to Mark: | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min | |
| | Mark Grade: | A | A | A | A | A | |
| 3 - Micro-Mill | Tool: | Center Drill | Center Drill | | | | |
| | Tool Cut Rate: | 2 in/min | 2 in/min | | | | |
| | Tool RPM: | 3000 RPM | 3000 RPM | | | | |
| | Lubrication: | Brushed Oil | Brushed Oil | | | | |
| | Depth: | 0.022 in | 0.022 in | | | | |
| | Hole Spacing: | 0.027 in | 0.027 in | | | | |
| | Tip: | 0.025 in | 0.025 in | | | | |
| | Total Time to Mark: | 18.5 min | 18.5 min | | | | |
| | Mark Grade: | A | A | | | | |
| 4 - Laser Bond | Marking Material: | LMM-6000 | LMM-6000 | LMM-6000 | LMM-6000 | LMM-6000 | LMM-6000 |
| | Material Manufacturer: | DMC2 | DMC2 | DMC2 | DMC2 | DMC2 | DMC2 |
| | Power: | 20.4 W | 20.4 W | 20.4 W | 20.4 W | 20.4 W | 20.4 W |
| | Current Setting: | 20 A | 20 A | 20 A | 20 A | 20 A | 20 A |
| | Frequency Setting: | 0 Hz | 0 Hz | 0 Hz | 0 Hz | 0 Hz | 0 Hz |
| | Speed Setting: | 20 mm/s | 20 mm/s | 20 mm/s | 20 mm/s | 20 mm/s | 20 mm/s |
| | Aperture: | 1.2 mm | 1.2 mm | 1.2 mm | 1.2 mm | 1.2 mm | 1.2 mm |
| | Total Time to Mark: | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min |
| | Mark Grade: | A | A | A | A | A | A |
| 5 - Laser Etch | Power: | 7.2 W | 6.7 W | 8.1 W | 8.4 W | 7.4 W | 8.6 W |
| | Current Setting: | 12.4 A | 12.0 A | 12.8 A | 13.0 A | 12.5 A | 13.2 A |
| | Frequency Setting: | 3000 Hz | 3000 Hz | 3000 Hz | 3000 Hz | 3000 Hz | 3000 Hz |
| | Speed Setting: | 20 mm/s | 20 mm/s | 20 mm/s | 30 mm/s | 30 mm/s | 40 mm/s |
| | Aperture: | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm |
| | Total Time to Mark: | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min |
| | Mark Grade: | A | A | A | B | A | B |
| 6 - Gas Assist Laser Etch (GALE) | Current Setting: | 60% | 60% | 60% | 60% | 60% | 60% |
| | Frequency Setting: | 20,000 Hz | 20,000 Hz | 20,000 Hz | 20,000 Hz | 20,000 Hz | 20,000 Hz |
| | Speed Setting: | 60 mm/s | 60 mm/s | 60 mm/s | 60 mm/s | 60 mm/s | 60 mm/s |
| | Total Time to Mark: | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min |
| | Mark Grade: | A | A | A | A | A | A |
| 7 - Laser Engrave | Power: | 55.7 W | 55.7 W | 55.7 W | 55.7 W | 55.7 W | 55.7 W |
| | Current Setting: | 20 A | 20 A | 20 A | 20 A | 20 A | 20 A |
| | Frequency Setting: | 20000 Hz | 3000 Hz | 3000 Hz | 3000 Hz | 3000 Hz | 3000 Hz |
| | Speed Setting: | 20 mm/s | 20 mm/s | 20 mm/s | 20 mm/s | 20 mm/s | 20 mm/s |
| | Aperture: | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm |
| | Total Time to Mark: | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min |
| | Mark Grade: | B | B | B | B | B | B |
| 8 - Laser Induce Surface Improvement (LISI) | Power: | 3W to 120W | 3W to 120W | 3W to 120W | 3W to 120W | 3W to 120W | 3W to 120W |
| | Power: | 95% | 95% | 95% | 95% | 95% | 95% |
| | Frequency Setting: | 10000 Hz | 10000 Hz | 10000 Hz | 40000 Hz | 40000 Hz | 40000 Hz |
| | Speed Setting: | 40 mm/s | 50 mm/s | 60 mm/s | 60 mm/s | 60 mm/s | 60 mm/s |
| | Wavelength: | 1064 nm | 1064 nm | 1064 nm | 1064 nm | 1064 nm | 1064 nm |
| | Total Time to Mark: | 1.5 min | 1.5 min | 1 min | 1 min | 1 min | 1 min |
| | Mark Grade: | A | A | B | B | B | B |
| 9 - Vibropeen | Tip: | 0.0625 in | 0.0625 in | 0.0625 in | | | |
| | Applied Pressure: | Low | Medium | High | | | |
| | Total Time to Mark: | 0.5 min | 0.5 min | 0.5 min | | | |
| 10 - Impression Stamp | Applied Pressure: | | | | | | |
| | Total Time to Mark: | | | | | | |

Comments:

2-LSP: LLNL did not provide process documentation for each mark. LSP marks on Side B.

3-MM: SP did not provide process documentation for each mark.

6-GALE: UTSI did not provide process documentation for each mark. GALE marks on Side B.

8-LISI: UTSI did not provide process documentation for each mark.

| | | | |
|---|---|---|---|
| | Prepared: SLM | Checked: DLR | Date: 3/29/01 |

# DPM PROCESS DATA SHEET
## COUPON: A1A-02

| DPM Process | DPM Process Data | Mark 1 | Mark 2 | Mark 3 | Mark 4 | Mark 5 | Mark 6 |
|---|---|---|---|---|---|---|---|
| 1 - Dot Peen | Stylus Configuration: | 30° | 30° | 30° | 30° | 30° | 30° |
| | Pressure Setting: | 80 psi | 80 psi | 80 psi | 80 psi | 80 psi | 80 psi |
| | Stylus to Substrate Gap: | 0.375 in | 0.375 in | 0.375 in | 0.375 in | 0.375 in | 0.375 in |
| | Cell Spacing: | 0.02 in | 0.019 in | 0.021 in | 0.0195 in | 0.0215 in | 0.022 in |
| | Total Time to Mark: | 1 min | 1 min | 1 min | 1 min | 1 min | 1 min |
| | Mark Grade: | A | A | A | A | A | A |
| 2 - LaserShot™ Peen | Fluence: | | | | | | |
| | Pulse Width: | | | | | | |
| | Wavelength: | | | | | | |
| | Rep Rate: | | | | | | |
| | Mark Size: | | | | | | |
| | Cell Size: | | | | | | |
| | Total Time to Mark: | | | | | | |
| | Mark Grade: | | | | | | |
| 3 - Micro-Mill | Tool: | Center Drill | Center Drill | | | | |
| | Tool Cut Rate: | 2 in/min | 2 in/min | | | | |
| | Tool RPM: | 3000 RPM | 3000 RPM | | | | |
| | Lubrication: | Brushed Oil | Brushed Oil | | | | |
| | Depth: | 0.022 in | 0.022 in | | | | |
| | Hole Spacing: | 0.027 in | 0.027 in | | | | |
| | Tip: | 0.025 in | 0.025 in | | | | |
| | Total Time to Mark: | 18.5 min | 18.5 min | | | | |
| | Mark Grade: | A | A | | | | |
| 4 - Laser Bond | Marking Material: | LMM-6000 | LMM-6000 | LMM-6000 | LMM-6000 | LMM-6000 | LMM-6000 |
| | Material Manufacturer: | DMC2 | DMC2 | DMC2 | DMC2 | DMC2 | DMC2 |
| | Power: | 30.4 W | 30.4 W | 30.4 W | 30.4 W | 30.4 W | 30.4 W |
| | Current Setting: | 20 A | 20 A | 20 A | 20 A | 20 A | 20 A |
| | Frequency Setting: | 0 Hz | 0 Hz | 0 Hz | 0 Hz | 0 Hz | 0 Hz |
| | Speed Setting: | 20 mm/s | 20 mm/s | 20 mm/s | 20 mm/s | 20 mm/s | 20 mm/s |
| | Aperture: | 1.2 mm | 1.2 mm | 1.2 mm | 1.2 mm | 1.2 mm | 1.2 mm |
| | Total Time to Mark: | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min |
| | Mark Grade: | A | A | A | A | A | A |
| 5 - Laser Etch | Power: | 7.2 W | 6.7 W | 8.1 W | 8.4 W | 7.4 W | 8.6 W |
| | Current Setting: | 12.4 A | 12.0 A | 12.8 A | 13.0 A | 12.5 A | 13.2 A |
| | Frequency Setting: | 3000 Hz | 3000 Hz | 3000 Hz | 3000 Hz | 3000 Hz | 3000 Hz |
| | Speed Setting: | 20 mm/s | 20 mm/s | 20 mm/s | 30 mm/s | 30 mm/s | 40 mm/s |
| | Aperture: | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm |
| | Total Time to Mark: | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min |
| | Mark Grade: | A | A | A | B | A | B |
| 6 - Gas Assist Laser Etch (GALE) | Current Setting: | | | | | | |
| | Frequency Setting: | | | | | | |
| | Speed Setting: | | | | | | |
| | Total Time to Mark: | | | | | | |
| | Mark Grade: | | | | | | |
| 7 - Laser Engrave | Power: | 55.7 W | 55.7 W | 55.7 W | | | |
| | Current Setting: | 20 A | 20 A | 20 A | | | |
| | Frequency Setting: | 20000 Hz | 3000 Hz | 3000 Hz | | | |
| | Speed Setting: | 20 mm/s | 20 mm/s | 20 mm/s | | | |
| | Aperture: | 2.4 mm | 2.4 mm | 2.4 mm | | | |
| | Total Time to Mark: | 0.5 min | 0.5 min | 0.5 min | | | |
| | Mark Grade: | B | B | B | | | |
| 8 - Laser Induce Surface Improvement (LISI) | Power: | 3W to 120W | 3W to 120W | 3W to 120W | 3W to 120W | 3W to 120W | 3W to 120W |
| | Power: | 95% | 95% | 95% | 95% | 95% | 95% |
| | Frequency Setting: | 10000 Hz | 10000 Hz | 10000 Hz | 40000 Hz | 40000 Hz | 40000 Hz |
| | Speed Setting: | 10 mm/s | 10 mm/s | 30 mm/s | 10 mm/s | 20 mm/s | 30 mm/s |
| | Wavelength: | 1064 nm | 1064 nm | 1064 nm | 1064 nm | 1064 nm | 1064 nm |
| | Total Time to Mark: | 1.5 min | 1.5 min | 0.5 min | 1.5 min | 0.5 min | 0.5 min |
| | Mark Grade: | A | A | A | A | A | A |
| 9 - Vibropeen | Tip: | 0.0625 in | 0.0625 in | 0.0625 in | | | |
| | Applied Pressure: | Low | Medium | High | | | |
| | Total Time to Mark: | 0.5 min | 0.5 min | 0.5 min | | | |
| 10 - Impression Stamp | Applied Pressure: | | | | | | |
| | Total Time to Mark: | | | | | | |

Comments:

2-LSP: LLNL did not provide process documentation for each mark.

3-MM: SP did not provide process documentation for each mark.

6-GALE: UTSI did not provide process documentation for each mark.

8-LISI: UTSI did not provide process documentation for each mark.

| | | | |
|---|---|---|---|
| | Prepared: SLM | Checked: DLR | Date: 3/29/01 |

# DPM PROCESS DATA SHEET
## COUPON: A1A-03

| DPM Process | DPM Process Data | Mark 1 | Mark 2 | Mark 3 | Mark 4 | Mark 5 | Mark 6 |
|---|---|---|---|---|---|---|---|
| 1 - Dot Peen | Stylus Configuration: | 30° | 30° | 30° | 30° | 30° | 30° |
| | Pressure Setting: | 60 psi | 60 psi | 60 psi | 60 psi | 60 psi | 60 psi |
| | Stylus to Substrate Gap: | 0.375 in | 0.375 in | 0.375 in | 0.375 in | 0.375 in | 0.375 in |
| | Cell Spacing: | 0.02 in | 0.019 in | 0.021 in | 0.0195 in | 0.0215 in | 0.022 in |
| | Total Time to Mark: | 1 min | 1 min | 1 min | 1 min | 1 min | 1 min |
| | Mark Grade: | B | B | B | B | B | B |
| 2 - LaserShot™ Peen | Fluence: | 120 J/cm2 | 120 J/cm2 | 120 J/cm2 | 120 J/cm2 | 120 J/cm2 | 120 J/cm2 |
| | Pulse Width: | 20 ns | 20 ns | 20 ns | 20 ns | 20 ns | 20 ns |
| | Wavelength: | 1053 nm | 1053 nm | 1053 nm | 1053 nm | 1053 nm | 1053 nm |
| | Rep Rate: | 1 Hz to 6 Hz | 1 Hz to 6 Hz | 1 Hz to 6 Hz | 1 Hz to 6 Hz | 1 Hz to 6 Hz | 1 Hz to 6 Hz |
| | Mark Size: | 8 mm | 8 mm | 8 mm | 8 mm | 8 mm | 8 mm |
| | Cell Size: | 0.57 mm | 0.57 mm | 0.57mm | 0.57mm | 0.57mm | 0.57mm |
| | Total Time to Mark: | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min |
| | Mark Grade: | A | A | A | A | A | A |
| 3 - Micro-Mill | Tool: | Center Drill | Center Drill | Center Drill | Center Drill | Center Drill | Center Drill |
| | Tool Cut Rate: | 2 in/min | 2 in/min | 2 in/min | 2 in/min | 2 in/min | 2 in/min |
| | Tool RPM: | 3000 RPM | 3000 RPM | 3000 RPM | 3000 RPM | 3000 RPM | 3000 RPM |
| | Lubrication: | Brushed Oil | Brushed Oil | Brushed Oil | Brushed Oil | Brushed Oil | Brushed Oil |
| | Depth: | 0.022 in | 0.022 in | 0.022 in | 0.022 in | 0.022 in | 0.022 in |
| | Hole Spacing: | 0.027 in | 0.027 in | 0.027 in | 0.027 in | 0.027 in | 0.027 in |
| | Tip: | 0.025 in | 0.025 in | 0.025 in | 0.025 in | 0.025 in | 0.025 in |
| | Total Time to Mark: | 18.5 min | 18.5 min | 18.5 min | 18.5 min | 18.5 min | 18.5 min |
| | Mark Grade: | A | A | A | A | A | A |
| 4 - Laser Bond | Marking Material: | LMM-6000 | LMM-6000 | LMM-6000 | LMM-6000 | LMM-6000 | LMM-6000 |
| | Material Manufacturer: | DMC2 | DMC2 | DMC2 | DMC2 | DMC2 | DMC2 |
| | Power: | 25.6 W | 27.7 W | 35.7 W | 25.8 W | 24.5 W | 24.3 W |
| | Current Setting: | 15 A | 16 A | 17 A | 15 A | 15 A | 15 A |
| | Frequency Setting: | 0 Hz | 0 Hz | 0 Hz | 0 Hz | 0 Hz | 0 Hz |
| | Speed Setting: | 20 mm/s | 20 mm/s | 20 mm/s | 10 mm/s | 5 mm/s | 15 mm/s |
| | Aperture: | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm |
| | Total Time to Mark: | 0.5 min | 0.5 min | 0.5 min | 1.0 min | 2.0 min | 1.0 min |
| | Mark Grade: | B | B | B | B | B | B |
| 5 - Laser Etch | Power: | 7.2 W | 6.7 W | 8.1 W | 8.4 W | 7.4 W | 8.6 W |
| | Current Setting: | 12.4 A | 12.0 A | 12.8 A | 13.0 A | 12.5 A | 13.2 A |
| | Frequency Setting: | 3000 Hz | 3000 Hz | 3000 Hz | 3000 Hz | 3000 Hz | 3000 Hz |
| | Speed Setting: | 20 mm/s | 20 mm/s | 20 mm/s | 30 mm/s | 30 mm/s | 40 mm/s |
| | Aperture: | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm |
| | Total Time to Mark: | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min |
| | Mark Grade: | A | A | A | B | A | B |
| 6 - Gas Assist Laser Etch (GALE) | Current Setting: | | | | | | |
| | Frequency Setting: | | | | | | |
| | Speed Setting: | | | | | | |
| | Total Time to Mark: | | | | | | |
| | Mark Grade: | | | | | | |
| 7 - Laser Engrave | Power: | 55.7 W | 55.7 W | 55.7 W | 55.7 W | 55.7 W | 55.7 W |
| | Current Setting: | 20 A | 20 A | 20 A | 20 A | 20 A | 20 A |
| | Frequency Setting: | 20000 Hz | 3000 Hz | 3000 Hz | 3000 Hz | 3000 Hz | 3000 Hz |
| | Speed Setting: | 20 mm/s | 20 mm/s | 20 mm/s | 20 mm/s | 20 mm/s | 20 mm/s |
| | Aperture: | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm |
| | Total Time to Mark: | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min |
| | Mark Grade: | B | B | B | B | B | B |
| 8 - Laser Induce Surface Improvement (LISI) | Power: | 3W to 120W | 3W to 120W | | | | |
| | Power: | 95% | 95% | | | | |
| | Frequency Setting: | 20000 Hz | 20000 Hz | | | | |
| | Speed Setting: | 30 mm/s | 30 mm/s | | | | |
| | Wavelength: | 1064 nm | 1064 nm | | | | |
| | Total Time to Mark: | 0.5 min | 0.5 min | | | | |
| | Mark Grade: | A | A | | | | |
| 9 - Vibropeen | Tip: | | | | | | |
| | Applied Pressure: | | | | | | |
| | Total Time to Mark: | | | | | | |
| 10 - Impression Stamp | Applied Pressure: | Low | Medium | High | | | |
| | Total Time to Mark: | 0.5 min | 0.5 min | 0.5 min | | | |

Comments:

2-LSP: LLNL did not provide process documentation for each mark.

3-MM: SP did not provide process documentation for each mark.

6-GALE: UTSI did not provide process documentation for each mark.

8-LISI: UTSI did not provide process documentation for each mark.

| | | | |
|---|---|---|---|
| | Prepared: SLM | Checked: DLR | Date: 3/29/01 |

# DPM PROCESS DATA SHEET
## COUPON: A1A-04

| DPM Process | DPM Process Data | Mark 1 | Mark 2 | Mark 3 | Mark 4 | Mark 5 | Mark 6 |
|---|---|---|---|---|---|---|---|
| 1 - Dot Peen | Stylus Configuration: | 30° | 30° | 30° | 30° | 30° | 30° |
| | Pressure Setting: | 80 psi | 80 psi | 80 psi | 80 psi | 80 psi | 80 psi |
| | Stylus to Substrate Gap: | 0.375 in | 0.375 in | 0.375 in | 0.375 in | 0.375 in | 0.375 in |
| | Cell Spacing: | 0.02 in | 0.019 in | 0.021 in | 0.0195 in | 0.0215 in | 0.022 in |
| | Total Time to Mark: | 1 min | 1 min | 1 min | 1 min | 1 min | 1 min |
| | Mark Grade: | A | A | A | A | A | A |
| 2 - LaserShot™ Peen | Fluence: | 120 J/cm2 | 120 J/cm2 | 120 J/cm2 | 120 J/cm2 | 120 J/cm2 | 120 J/cm2 |
| | Pulse Width: | 20 ns | 20 ns | 20 ns | 20 ns | 20 ns | 20 ns |
| | Wavelength: | 1053 nm | 1053 nm | 1053 nm | 1053 nm | 1053 nm | 1053 nm |
| | Rep Rate: | 1 Hz to 6 Hz | 1 Hz to 6 Hz | 1 Hz to 6 Hz | 1 Hz to 6 Hz | 1 Hz to 6 Hz | 1 Hz to 6 Hz |
| | Mark Size: | 8 mm | 8 mm | 8 mm | 8 mm | 8 mm | 8 mm |
| | Cell Size: | 0.57 mm | 0.57 mm | 0.57mm | 0.57mm | 0.57mm | 0.57mm |
| | Total Time to Mark: | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min |
| | Mark Grade: | A | A | A | A | A | A |
| 3 - Micro-Mill | Tool: | Center Drill | Center Drill | Center Drill | Center Drill | Center Drill | Center Drill |
| | Tool Cut Rate: | 2 in/min | 2 in/min | 2 in/min | 2 in/min | 2 in/min | 2 in/min |
| | Tool RPM: | 3000 RPM | 3000 RPM | 3000 RPM | 3000 RPM | 3000 RPM | 3000 RPM |
| | Lubrication: | Brushed Oil | Brushed Oil | Brushed Oil | Brushed Oil | Brushed Oil | Brushed Oil |
| | Depth: | 0.022 in | 0.022 in | 0.022 in | 0.022 in | 0.022 in | 0.022 in |
| | Hole Spacing: | 0.027 in | 0.027 in | 0.027 in | 0.027 in | 0.027 in | 0.027 in |
| | Tip: | 0.025 in | 0.025 in | 0.025 in | 0.025 in | 0.025 in | 0.025 in |
| | Total Time to Mark: | 18.5 min | 18.5 min | 18.5 min | 18.5 min | 18.5 min | 18.5 min |
| | Mark Grade: | A | A | A | A | A | A |
| 4 - Laser Bond | Marking Material: | LMM-6000 | LMM-6000 | LMM-6000 | LMM-6000 | LMM-6000 | LMM-6000 |
| | Material Manufacturer: | DMC2 | DMC2 | DMC2 | DMC2 | DMC2 | DMC2 |
| | Power: | 34.9 W | 18.0 W | 32.7 W | 28.8 W | 18.1 W | 17.9 W |
| | Current Setting: | 16 A | 14 A | 16 A | 16 A | 14 A | 14 A |
| | Frequency Setting: | 0 Hz | 0 Hz | 0 Hz | 0 Hz | 0 Hz | 0 Hz |
| | Speed Setting: | 10 mm/s | 10 mm/s | 5 mm/s | 15 mm/s | 5 mm/s | 15 mm/s |
| | Aperture: | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm |
| | Total Time to Mark: | 0.5 min | 1.0 min | 2.0 min | 1.0 min | 2.0 min | 1.0 min |
| | Mark Grade: | B | B | B | B | B | B |
| 5 - Laser Etch | Power: | 7.9 W | 8.3 W | 5.2 W | 6.9 W | 9.1 W | 8.6 W |
| | Current Setting: | 12.0 A | 12.0 A | 12.8 A | 12.2 A | 13.5 A | 12.2 A |
| | Frequency Setting: | 5000 Hz | 7000 Hz | 2000 Hz | 3000 Hz | 3000 Hz | 5000 Hz |
| | Speed Setting: | 20 mm/s | 20 mm/s | 20 mm/s | 20 mm/s | 50 mm/s | 20 mm/s |
| | Aperture: | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm |
| | Total Time to Mark: | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min |
| | Mark Grade: | A | A | A | A | B | A |
| 6 - Gas Assist Laser Etch (GALE) | Current Setting: | | | | | | |
| | Frequency Setting: | | | | | | |
| | Speed Setting: | | | | | | |
| | Total Time to Mark: | | | | | | |
| | Mark Grade: | | | | | | |
| 7 - Laser Engrave | Power: | 55.7 W | 55.7 W | 55.7 W | 55.7 W | 55.7 W | 55.7 W |
| | Current Setting: | 20 A | 20 A | 20 A | 20 A | 20 A | 20 A |
| | Frequency Setting: | 20000 Hz | 3000 Hz | 3000 Hz | 3000 Hz | 3000 Hz | 3000 Hz |
| | Speed Setting: | 20 mm/s | 20 mm/s | 20 mm/s | 20 mm/s | 20 mm/s | 20 mm/s |
| | Aperture: | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm |
| | Total Time to Mark: | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min |
| | Mark Grade: | B | B | B | B | B | B |
| 8 - Laser Induce Surface Improvement (LISI) | Power: | 3W to 120W | 3W to 120W | | | | |
| | Power: | 95% | 95% | | | | |
| | Frequency Setting: | 20000 Hz | 20000 Hz | | | | |
| | Speed Setting: | 30 mm/s | 30 mm/s | | | | |
| | Wavelength: | 1064 nm | 1064 nm | | | | |
| | Total Time to Mark: | 0.5 min | 0.5 min | | | | |
| | Mark Grade: | A | A | | | | |
| 9 - Vibropeen | Tip: | | | | | | |
| | Applied Pressure: | | | | | | |
| | Total Time to Mark: | | | | | | |
| 10 - Impression Stamp | Applied Pressure: | Low | Medium | High | | | |
| | Total Time to Mark: | 0.5 min | 0.5 min | 0.5 min | | | |

Comments:

2-LSP: LLNL did not provide process documentation for each mark.

3-MM: SP did not provide process documentation for each mark.

6-GALE: UTSI did not provide process documentation for each mark.

8-LISI: UTSI did not provide process documentation for each mark.

| | | | |
|---|---|---|---|
| | Prepared: SLM | Checked: DLR | Date: 3/29/01 |

# DPM PROCESS DATA SHEET
## COUPON: A1A-05 to A1A-16 : A2A-01 to A2A-06

| DPM Process | Marking Process Data | A1A Marks | A2A Marks |
|---|---|---|---|
| 1 - Dot Peen | Stylus Configuration: | 30° | 30° |
| | Pressure Setting: | 80 psi | 80 psi |
| | Stylus to Substrate Gap: | 0.375 in | 0.375 in |
| | Cell Spacing: | 0.021 in | 0.021 in |
| | Total Time to Mark: | 3.5 min | 1.5 min |
| | Mark Grade: | A | A |
| 2 - LaserShot™ Peen | Fluence: | 120 J/cm2 | 120 J/cm2 |
| | Pulse Width: | 20 ns | 20 ns |
| | Wavelength: | 1053 nm | 1053 nm |
| | Rep Rate: | 1 Hz to 6 Hz | 1 Hz to 6 Hz |
| | Mark Size: | 12.5 mm | 12.5 mm |
| | Cell Size: | 0.57 mm | 0.57 mm |
| | Total Time to Mark: | 1.5 min | 1 min |
| | Mark Grade: | A | A |
| 3 - Micro-Mill | Tool: | Center Drill | Center Drill |
| | Tool Cut Rate: | 3 in/min | 3 in/min |
| | Tool RPM: | 3000 RPM | 3000 RPM |
| | Lubrication: | Brushed Oil | Brushed Oil |
| | Depth: | 0.03 in | 0.03 in |
| | Hole Spacing: | 0.034 in | 0.034 in |
| | Tip: | 0.031 in | 0.031 in |
| | Total Time to Mark: | 11 min | 11 min |
| | Mark Grade: | A | A |
| 4 - Laser Bond | Marking Material: | LMM-6000 | LMM-6000 |
| | Material Manufacturer: | DMC2 | DMC2 |
| | Power: | 28.7 W | 28.7 W |
| | Current Setting: | 15.5 amps | 15.5 amps |
| | Frequency Setting: | 0 Hz | 0 Hz |
| | Speed Setting: | 10 mm/s | 10 mm/s |
| | Aperture: | 2.4 mm | 2.4 mm |
| | Total Time to Mark: | 11 min | 4 min |
| | Mark Grade: | A | A |
| 5 - Laser Etch | Power: | 7.1 W | 7.1 W |
| | Current Setting: | 12 amps | 12 amps |
| | Frequency Setting: | 3000 Hz | 3000 Hz |
| | Speed Setting: | 20 mm/s | 20 mm/s |
| | Aperture: | 2.4 mm | 2.4 mm |
| | Total Time to Mark: | 5.5 min | 2 min |
| | Mark Grade: | A | A |
| 6 - Gas Assist Laser Etch (GALE) | Current Setting: | 60% | 60% |
| | Frequency Setting: | 20,000 Hz | 20,000 Hz |
| | Speed Setting: | 60 mm/s | 60 mm/s |
| | Total Time to Mark: | 3.5 min | 1.5 min |
| | Mark Grade: | A | A |
| 7 - Laser Engrave | Power: | 55.7 W | 55.7 W |
| | Current Setting: | 20 amps | 20 amps |
| | Frequency Setting: | 3000 Hz | 3000 Hz |
| | Speed Setting: | 20 mm/s | 20 mm/s |
| | Aperture: | 2.4 mm | 2.4 mm |
| | Total Time to Mark: | 5.5 min | 2 min |
| | Mark Grade: | B | B |
| 8 - Laser Induce Surface Improvement (LISI) | Power: | 3W to 120W | 3W to 120W |
| | Power: | 95% | 95% |
| | Frequency Setting: | 20000 Hz | 20000 Hz |
| | Speed Setting: | 30 mm/s | 30 mm/s |
| | Wavelength: | 1064 nm | 1064 nm |
| | Total Time to Mark: | 0.5 min | 0.5 min |
| | Mark Grade: | A | A |
| 9 - Vibropeen | Tip: | 0.0625 in | 0.0625 in |
| | Applied Pressure: | Low | Low |
| | Total Time to Mark: | 0.5 min | 0.5 min |
| 10 - Impression Stamp | Applied Pressure: | High | High |
| | Total Time to Mark: | 0.5 min | 0.5 min |

Comments:

9-V: Low pressure was applied in accordance with strut marking practices after heat treatment.

10-IS: High pressure was applied in accordance with wheel marking practices.

| Prepared: SLM | Checked: DLR | Date: 3/29/01 |
|---|---|---|

# DPM PROCESS DATA SHEET
## COUPON: S1A-01

| DPM Process | DPM Process Data | Mark 1 | Mark 2 | Mark 3 | Mark 4 | Mark 5 | Mark 6 |
|---|---|---|---|---|---|---|---|
| 1 - Dot Peen | Stylus Configuration: | 30° | 30° | 30° | 30° | 30° | 30° |
| | Pressure Setting: | 80 psi | 80 psi | 80 psi | 80 psi | 80 psi | 80 psi |
| | Stylus to Substrate Gap: | 0.375 in | 0.375 in | 0.375 in | 0.375 in | 0.375 in | 0.375 in |
| | Cell Spacing: | 0.02 in | 0.0205 in | 0.0205 in | 0.0205 in | 0.0205 in | 0.0205 in |
| | Total Time to Mark: | 1 min | 1 min | 1 min | 1 min | 1 min | 1 min |
| | Mark Grade: | B | B | B | B | B | B |
| 2 - LaserShot™ Peen | Fluence: | 120 J/cm2 | 120 J/cm2 | 120 J/cm2 | 120 J/cm2 | 120 J/cm2 | 120 J/cm2 |
| | Pulse Width: | 20 ns | 20 ns | 20 ns | 20 ns | 20 ns | 20 ns |
| | Wavelength: | 1053 nm | 1053 nm | 1053 nm | 1053 nm | 1053 nm | 1053 nm |
| | Rep Rate: | 1 Hz to 6 Hz | 1 Hz to 6 Hz | 1 Hz to 6 Hz | 1 Hz to 6 Hz | 1 Hz to 6 Hz | 1 Hz to 6 Hz |
| | Mark Size: | 8 mm | 8 mm | 8 mm | 8 mm | 8 mm | 8 mm |
| | Cell Size: | 0.57 mm | 0.57 mm | 0.57 mm | 0.57 mm | 0.57 mm | 0.57 mm |
| | Total Time to Mark: | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min |
| | Mark Grade: | C | C | C | C | C | C |
| 3 - Micro-Mill | Tool: | Center Drill | Center Drill | Center Drill | | | |
| | Tool Cut Rate: | 1.92 in/min | 1.92 in/min | 1.92 in/min | | | |
| | Tool RPM: | 8000 RPM | 8000 RPM | 8000 RPM | | | |
| | Lubrication: | Brushed Oil | Brushed Oil | Brushed Oil | | | |
| | Depth: | 0.027 in | 0.027 in | 0.027 in | | | |
| | Hole Spacing: | 0.034 in | 0.034 in | 0.034 in | | | |
| | Tip: | 0.031 in | 0.031 in | 0.031 in | | | |
| | Total Time to Mark: | 14 min | 14 min | 14 min | | | |
| | Mark Grade: | B | B | B | | | |
| 4 - Laser Bond | Marking Material: | LMM-6000 | LMM-6000 | LMM-6000 | LMM-6000 | LMM-6000 | LMM-6000 |
| | Material Manufacturer: | DMC2 | DMC2 | DMC2 | DMC2 | DMC2 | DMC2 |
| | Power: | 3 W | 3.2 W | 3 W | 3.5 W | 2.7 W | 3.9 W |
| | Current Setting: | 17 A | 17 A | 17 A | 17 A | 16.5 A | 18 A |
| | Frequency Setting: | 0 Hz | 0 Hz | 0 Hz | 0 Hz | 0 Hz | 0 Hz |
| | Speed Setting: | 50 mm/s | 35 mm/s | 60 mm/s | 20 mm/s | 50 mm/s | 50 mm/s |
| | Aperture: | 1.2 mm | 1.2 mm | 1.2 mm | 1.2 mm | 1.2 mm | 1.2 mm |
| | Total Time to Mark: | 0.5 min | 0.5 min | 0.5 min | 1 min | 0.5 min | 0.5 min |
| | Mark Grade: | B | B | B | B | B | B |
| 5 - Laser Etch | Power: | 10.9 W | 4.9 W | 5.2 W | 2.2 W | 1.2 W | 9.6 W |
| | Current Setting: | 13.5 A | 11.0 A | 11.0 A | 10.0 A | 11.0 A | 13.0 A |
| | Frequency Setting: | 5000 Hz | 7000 Hz | 9000 Hz | 3000 Hz | 1000 Hz | 7000 Hz |
| | Speed Setting: | 20 mm/s | 20 mm/s | 20 mm/s | 15 mm/s | 20 mm/s | 40 mm/s |
| | Aperture: | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm |
| | Total Time to Mark: | 0.5 min | 1 min | 1 min | 1 min | 1 min | 0.5 min |
| | Mark Grade: | B | B | B | B | B | B |
| 6 - Gas Assist Laser Etch (GALE) | Current Setting: | 95% | 95% | 95% | 95% | 95% | 95% |
| | Frequency Setting: | 20,000 Hz | 20,000 Hz | 20,000 Hz | 20,000 Hz | 20,000 Hz | 20,000 Hz |
| | Speed Setting: | 200 mm/s | 200 mm/s | 200 mm/s | 200 mm/s | 200 mm/s | 200 mm/s |
| | Total Time to Mark: | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min |
| | Mark Grade: | B | B | B | B | B | B |
| 7 - Laser Engrave | Power: | 55.7 W | 55.7 W | 55.7 W | 55.7 W | 55.7 W | 55.7 W |
| | Current Setting: | 20 A | 20 A | 20 A | 20 A | 20 A | 20 A |
| | Frequency Setting: | 20000 Hz | 20000 Hz | 20000 Hz | 20000 Hz | 20000 Hz | 20000 Hz |
| | Speed Setting: | 20 mm/s | 20 mm/s | 20 mm/s | 20 mm/s | 20 mm/s | 20 mm/s |
| | Aperture: | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm |
| | Total Time to Mark: | 1 min | 1 min | 1 min | 1 min | 1 min | 1 min |
| | Mark Grade: | B | B | B | B | B | B |
| 8 - Laser Induce Surface Improvement (LISI) | Power: | 3W to 120W | 3W to 120W | 3W to 120W | 3W to 120W | 3W to 120W | 3W to 120W |
| | Power: | 95% | 95% | 95% | 95% | 95% | 95% |
| | Frequency Setting: | 20000 Hz | 20000 Hz | 20000 Hz | 20000 Hz | 20000 Hz | 20000 Hz |
| | Speed Setting: | 30 mm/s | 30 mm/s | 30 mm/s | 30 mm/s | 30 mm/s | 30 mm/s |
| | Wavelength: | 1064 nm | 1064 nm | 1064 nm | 1064 nm | 1064 nm | 1064 nm |
| | Total Time to Mark: | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min |
| | Mark Grade: | B | B | B | B | B | B |
| 9 - Vibropeen | Tip: | 0.0625 in | 0.0625 in | 0.0625 in | | | |
| | Applied Pressure: | Low | Medium | High | | | |
| | Total Time to Mark: | 0.5 min | 0.5 min | 0.5 min | | | |
| 10 - Impression Stamp | Applied Pressure: | | | | | | |
| | Total Time to Mark: | | | | | | |

Comments:

Coupons S1A were abrasive blasted to remove the discolored oxide layer prior to marking. MIL-STD-1504, ALUMINUM OXIDE, 180 GRIT OR FINER was used as a guide.

2-LSP: LLNL did not provide process documentation for each mark.

3-MM: SP did not provide process documentation for each mark.

6-GALE: UTSI did not provide process documentation for each mark. GALE marks on Side B.

8-LISI: UTSI did not provide process documentation for each mark.

| | | |
|---|---|---|
| Prepared: SLM | Checked: DLR | Date: 3/29/01 |

# DPM PROCESS DATA SHEET
## COUPON: S1A-02

| DPM Process | DPM Process Data | Mark 1 | Mark 2 | Mark 3 | Mark 4 | Mark 5 | Mark 6 |
|---|---|---|---|---|---|---|---|
| 1 - Dot Peen | Stylus Configuration: | 30° | 30° | 30° | 30° | 30° | 30° |
| | Pressure Setting: | 90 psi | 90 psi | 90 psi | 90 psi | 90 psi | 90 psi |
| | Stylus to Substrate Gap: | 0.425 in | 0.425 in | 0.425 in | 0.425 in | 0.425 in | 0.425 in |
| | Cell Spacing: | 0.02 in | 0.02 in | 0.02 in | 0.02 in | 0.02 in | 0.02 in |
| | Total Time to Mark: | 1 min | 1 min | 1 min | 1 min | 1 min | 1 min |
| | Mark Grade: | B | B | B | B | B | B |
| 2 - LaserShot™ Peen | Fluence: | 120 J/cm2 | 120 J/cm2 | 120 J/cm2 | 120 J/cm2 | 120 J/cm2 | 120 J/cm2 |
| | Pulse Width: | 20 ns | 20 ns | 20 ns | 20 ns | 20 ns | 20 ns |
| | Wavelength: | 1053 nm | 1053 nm | 1053 nm | 1053 nm | 1053 nm | 1053 nm |
| | Rep Rate: | 1 Hz to 6 Hz | 1 Hz to 6 Hz | 1 Hz to 6 Hz | 1 Hz to 6 Hz | 1 Hz to 6 Hz | 1 Hz to 6 Hz |
| | Mark Size: | 8 mm | 8 mm | 8 mm | 8 mm | 8 mm | 8 mm |
| | Cell Size: | 0.57 mm | 0.57 mm | 0.57 mm | 0.57 mm | 0.57 mm | 0.57 mm |
| | Total Time to Mark: | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min |
| | Mark Grade: | C | C | C | C | C | C |
| 3 - Micro-Mill | Tool: | Center Drill | Center Drill | | | | |
| | Tool Cut Rate: | 1.92 in/min | 1.92 in/min | | | | |
| | Tool RPM: | 8000 RPM | 8000 RPM | | | | |
| | Lubrication: | Brushed Oil | Brushed Oil | | | | |
| | Depth: | 0.027 in | 0.027 in | | | | |
| | Hole Spacing: | 0.034 in | 0.034 in | | | | |
| | Tip: | 0.031 in | 0.031 in | | | | |
| | Total Time to Mark: | 14 min | 14 min | | | | |
| | Mark Grade: | B | B | | | | |
| 4 - Laser Bond | Marking Material: | LMM-6000 | LMM-6000 | LMM-6000 | LMM-6000 | LMM-6000 | LMM-6000 |
| | Material Manufacturer: | DMC2 | DMC2 | DMC2 | DMC2 | DMC2 | DMC2 |
| | Power: | 5.4 W | 1.7 W | 4.6 W | 5.5 W | 1.3 W | 1.6 W |
| | Current Setting: | 20 A | 15 A | 20 A | 20 A | 15 A | 15 A |
| | Frequency Setting: | 0 Hz | 0 Hz | 0 Hz | 0 Hz | 0 Hz | 0 Hz |
| | Speed Setting: | 20 mm/s | 20 mm/s | 40 mm/s | 10 mm/s | 10 mm/s | 20 mm/s |
| | Aperture: | 1.2 mm | 1.2 mm | 1.2 mm | 1.2 mm | 1.2 mm | 1.2 mm |
| | Total Time to Mark: | 0.5 min | 0.5 min | 0.5 min | 1 min | 1.0 min | 0.5 min |
| | Mark Grade: | B | B | B | B | B | B |
| 5 - Laser Etch | Power: | 3.8 W | | | | | |
| | Current Setting: | 11.0 A | | | | | |
| | Frequency Setting: | 3000 Hz | | | | | |
| | Speed Setting: | 20 mm/s | | | | | |
| | Aperture: | 2.4 mm | | | | | |
| | Total Time to Mark: | 0.5 min | | | | | |
| | Mark Grade: | B | | | | | |
| 6 - Gas Assist Laser Etch (GALE) | Current Setting: | 95% | 95% | 95% | 95% | 95% | 95% |
| | Frequency Setting: | 20,000 Hz | 20,000 Hz | 20,000 Hz | 20,000 Hz | 20,000 Hz | 20,000 Hz |
| | Speed Setting: | 200 mm/s | 200 mm/s | 200 mm/s | 200 mm/s | 200 mm/s | 200 mm/s |
| | Total Time to Mark: | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min |
| | Mark Grade: | B | B | B | B | B | B |
| 7 - Laser Engrave | Power: | 55.7 W | 55.7 W | 55.7 W | 55.7 W | 55.7 W | 55.7 W |
| | Current Setting: | 20 A | 20 A | 20 A | 20 A | 20 A | 20 A |
| | Frequency Setting: | 20000 Hz | 20000 Hz | 20000 Hz | 20000 Hz | 20000 Hz | 20000 Hz |
| | Speed Setting: | 20 mm/s | 20 mm/s | 20 mm/s | 20 mm/s | 20 mm/s | 20 mm/s |
| | Aperture: | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm |
| | Total Time to Mark: | 1 min | 1 min | 1 min | 1 min | 1 min | 1 min |
| | Mark Grade: | B | B | B | B | B | B |
| 8 - Laser Induce Surface Improvement (LISI) | Power: | | | | | | |
| | Power: | | | | | | |
| | Frequency Setting: | | | | | | |
| | Speed Setting: | | | | | | |
| | Wavelength: | | | | | | |
| | Total Time to Mark: | | | | | | |
| | Mark Grade: | | | | | | |
| 9 - Vibropeen | Tip: | 0.0625 in | 0.0625 in | 0.0625 in | | | |
| | Applied Pressure: | Low | Medium | High | | | |
| | Total Time to Mark: | 0.5 min | 0.5 min | 0.5 min | | | |
| 10 - Impression Stamp | Applied Pressure: | | | | | | |
| | Total Time to Mark: | | | | | | |

Comments:

Coupons S1A were abrasive blasted to remove the discolored oxide layer prior to marking. MIL-STD-1504, ALUMINUM OXIDE, 180 GRIT OR FINER was used as a guide.

2-LSP: LLNL did not provide process documentation for each mark.

3-MM: SP did not provide process documentation for each mark.

6-GALE: UTSI did not provide process documentation for each mark.

8-LISI: UTSI did not provide process documentation for each mark.

| | | | |
|---|---|---|---|
| | Prepared: SLM | Checked: DLR | Date: 3/29/01 |

# DPM PROCESS DATA SHEET
## COUPON: S1A-03

| DPM Process | DPM Process Data | Mark 1 | Mark 2 | Mark 3 | Mark 4 | Mark 5 | Mark 6 |
|---|---|---|---|---|---|---|---|
| 1 - Dot Peen | Stylus Configuration: | 30° | 30° | 30° | 30° | 30° | 30° |
| | Pressure Setting: | 80 psi | 80 psi | 80 psi | 80 psi | 80 psi | 80 psi |
| | Stylus to Substrate Gap: | 0.375 in | 0.375 in | 0.375 in | 0.375 in | 0.375 in | 0.375 in |
| | Cell Spacing: | 0.02 in | 0.0205 in | 0.0205 in | 0.0205 in | 0.0205 in | 0.0205 in |
| | Total Time to Mark: | 1 min | 1 min | 1 min | 1 min | 1 min | 1 min |
| | Mark Grade: | B | B | B | B | B | B |
| 2 - LaserShot™ Peen | Fluence: | 120 J/cm2 | 120 J/cm2 | 120 J/cm2 | 120 J/cm2 | 120 J/cm2 | 120 J/cm2 |
| | Pulse Width: | 20 ns | 20 ns | 20 ns | 20 ns | 20 ns | 20 ns |
| | Wavelength: | 1053 nm | 1053 nm | 1053 nm | 1053 nm | 1053 nm | 1053 nm |
| | Rep Rate: | 1 Hz to 6 Hz | 1 Hz to 6 Hz | 1 Hz to 6 Hz | 1 Hz to 6 Hz | 1 Hz to 6 Hz | 1 Hz to 6 Hz |
| | Mark Size: | 8 mm | 8 mm | 8 mm | 8 mm | 8 mm | 8 mm |
| | Cell Size: | 0.57 mm | 0.57 mm | 0.57 mm | 0.57 mm | 0.57 mm | 0.57 mm |
| | Total Time to Mark: | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min |
| | Mark Grade: | C | C | C | C | C | C |
| 3 - Micro-Mill | Tool: | Center Drill | Center Drill | | | | |
| | Tool Cut Rate: | 1.92 in/min | 1.92 in/min | | | | |
| | Tool RPM: | 8000 RPM | 8000 RPM | | | | |
| | Lubrication: | Brushed Oil | Brushed Oil | | | | |
| | Depth: | 0.027 in | 0.027 in | | | | |
| | Hole Spacing: | 0.034 in | 0.034 in | | | | |
| | Tip: | 0.031 in | 0.031 in | | | | |
| | Total Time to Mark: | 14 min | 14 min | | | | |
| | Mark Grade: | B | B | | | | |
| 4 - Laser Bond | Marking Material: | LMM-6000 | LMM-6000 | LMM-6000 | LMM-6000 | LMM-6000 | LMM-6000 |
| | Material Manufacturer: | DMC2 | DMC2 | DMC2 | DMC2 | DMC2 | DMC2 |
| | Power: | 3 W | 3.2 W | 3 W | 3.5 W | 2.7 W | 3.9 W |
| | Current Setting: | 17 A | 17 A | 17 A | 17 A | 16.5 A | 18 A |
| | Frequency Setting: | 0 Hz | 0 Hz | 0 Hz | 0 Hz | 0 Hz | 0 Hz |
| | Speed Setting: | 50 mm/s | 35 mm/s | 60 mm/s | 20 mm/s | 50 mm/s | 50 mm/s |
| | Aperture: | 1.2 mm | 1.2 mm | 1.2 mm | 1.2 mm | 1.2 mm | 1.2 mm |
| | Total Time to Mark: | 0.5 min | 0.5 min | 0.5 min | 1 min | 0.5 min | 0.5 min |
| | Mark Grade: | B | B | B | B | B | B |
| 5 - Laser Etch | Power: | 10.9 W | 4.9 W | 5.2 W | 2.2 W | 1.2 W | 9.6 W |
| | Current Setting: | 13.5 A | 11.0 A | 11.0 A | 10.0 A | 11.0 A | 13.0 A |
| | Frequency Setting: | 5000 Hz | 7000 Hz | 9000 Hz | 3000 Hz | 1000 Hz | 7000 Hz |
| | Speed Setting: | 30 mm/s | 20 mm/s | 20 mm/s | 15 mm/s | 20 mm/s | 40 mm/s |
| | Aperture: | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm |
| | Total Time to Mark: | 0.5 min | 1 min | 1 min | 1 min | 1 min | 0.5 min |
| | Mark Grade: | B | B | B | B | B | B |
| 6 - Gas Assist Laser Etch (GALE) | Current Setting: | | | | | | |
| | Frequency Setting: | | | | | | |
| | Speed Setting: | | | | | | |
| | Total Time to Mark: | | | | | | |
| | Mark Grade: | | | | | | |
| 7 - Laser Engrave | Power: | 55.7 W | 55.7 W | 55.7 W | 55.7 W | 55.7 W | 55.7 W |
| | Current Setting: | 20 A | 20 A | 20 A | 20 A | 20 A | 20 A |
| | Frequency Setting: | 20000 Hz | 20000 Hz | 20000 Hz | 20000 Hz | 20000 Hz | 20000 Hz |
| | Speed Setting: | 20 mm/s | 20 mm/s | 20 mm/s | 20 mm/s | 20 mm/s | 20 mm/s |
| | Aperture: | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm |
| | Total Time to Mark: | 1 min | 1 min | 1 min | 1 min | 1 min | 1 min |
| | Mark Grade: | B | B | B | B | B | B |
| 8 - Laser Induce Surface Improvement (LISI) | Power: | | | | | | |
| | Power: | | | | | | |
| | Frequency Setting: | | | | | | |
| | Speed Setting: | | | | | | |
| | Wavelength: | | | | | | |
| | Total Time to Mark: | | | | | | |
| | Mark Grade: | | | | | | |
| 9 - Vibropeen | Tip: | | | | | | |
| | Applied Pressure: | | | | | | |
| | Total Time to Mark: | | | | | | |
| 10 - Impression Stamp | Applied Pressure: | Low | Medium | High | | | |
| | Total Time to Mark: | 0.5 min | 0.5 min | 0.5 min | | | |

Comments:

Coupons S1A were abrasive blasted to remove the discolored oxide layer prior to marking. MIL-STD-1504, ALUMINUM OXIDE, 180 GRIT OR FINER was used as a guide.

2-LSP: LLNL did not provide process documentation for each mark.

3-MM: SP did not provide process documentation for each mark.

6-GALE: UTSI did not provide process documentation for each mark.

8-LISI: UTSI did not provide process documentation for each mark.

| | | |
|---|---|---|
| Prepared: SLM | Checked: DLR | Date: 3/29/01 |

# DPM PROCESS DATA SHEET
## COUPON: S1A-04

| DPM Process | DPM Process Data | Mark 1 | Mark 2 | Mark 3 | Mark 4 | Mark 5 | Mark 6 |
|---|---|---|---|---|---|---|---|
| 1 - Dot Peen | Stylus Configuration: | 30° | 30° | 30° | 30° | 30° | 30° |
| | Pressure Setting: | 90 psi | 90 psi | 90 psi | 90 psi | 90 psi | 90 psi |
| | Stylus to Substrate Gap: | 0.425 in | 0.425 in | 0.425 in | 0.425 in | 0.425 in | 0.425 in |
| | Cell Spacing: | 0.02 in | 0.0205 in | 0.0205 in | 0.0205 in | 0.0205 in | 0.0205 in |
| | Total Time to Mark: | 1 min | 1 min | 1 min | 1 min | 1 min | 1 min |
| | Mark Grade: | B | B | B | B | B | B |
| 2 - LaserShot™ Peen | Fluence: | 120 J/cm2 | 120 J/cm2 | 120 J/cm2 | 120 J/cm2 | 120 J/cm2 | 120 J/cm2 |
| | Pulse Width: | 20 ns | 20 ns | 20 ns | 20 ns | 20 ns | 20 ns |
| | Wavelength: | 1053 nm | 1053 nm | 1053 nm | 1053 nm | 1053 nm | 1053 nm |
| | Rep Rate: | 1 Hz to 6 Hz | 1 Hz to 6 Hz | 1 Hz to 6 Hz | 1 Hz to 6 Hz | 1 Hz to 6 Hz | 1 Hz to 6 Hz |
| | Mark Size: | 8 mm | 8 mm | 8 mm | 8 mm | 8 mm | 8 mm |
| | Cell Size: | 0.57 mm | 0.57 mm | 0.57 mm | 0.57 mm | 0.57 mm | 0.57 mm |
| | Total Time to Mark: | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min |
| | Mark Grade: | C | C | C | C | C | C |
| 3 - Micro-Mill | Tool: | Center Drill | Center Drill | | | | |
| | Tool Cut Rate: | 1.92 in/min | 1.92 in/min | | | | |
| | Tool RPM: | 8000 RPM | 8000 RPM | | | | |
| | Lubrication: | Brushed Oil | Brushed Oil | | | | |
| | Depth: | 0.027 in | 0.027 in | | | | |
| | Hole Spacing: | 0.034 in | 0.034 in | | | | |
| | Tip: | 0.031 in | 0.031 in | | | | |
| | Total Time to Mark: | 14 min | 14 min | | | | |
| | Mark Grade: | B | B | | | | |
| 4 - Laser Bond | Marking Material: | LMM-6000 | LMM-6000 | LMM-6000 | LMM-6000 | LMM-6000 | LMM-6000 |
| | Material Manufacturer: | DMC2 | DMC2 | DMC2 | DMC2 | DMC2 | DMC2 |
| | Power: | 5.4 W | 1.7 W | 4.6 W | 5.5 W | 1.3 W | 1.6 W |
| | Current Setting: | 20 A | 15 A | 20 A | 20 A | 15 A | 15 A |
| | Frequency Setting: | 0 Hz | 0 Hz | 0 Hz | 0 Hz | 0 Hz | 0 Hz |
| | Speed Setting: | 20 mm/s | 20 mm/s | 40 mm/s | 10 mm/s | 10 mm/s | 5 mm/s |
| | Aperture: | 1.2 mm | 1.2 mm | 1.2 mm | 1.2 mm | 1.2 mm | 1.2 mm |
| | Total Time to Mark: | 0.5 min | 0.5 min | 0.5 min | 1 min | 1 min | 2.0 min |
| | Mark Grade: | B | B | B | B | B | B |
| 5 - Laser Etch | Power: | 3.8 W | 6.4 W | 9.6 W | 5.7 W | 7.8 W | 5.6 W |
| | Current Setting: | 11.0 A | 12.0 A | 13.0 A | 12.0 A | 12.0 A | 13.0 A |
| | Frequency Setting: | 3000 Hz | 4000 Hz | 5000 Hz | 3000 Hz | 5000 Hz | 2000 Hz |
| | Speed Setting: | 20 mm/s | 20 mm/s | 20 mm/s | 20 mm/s | 20 mm/s | 20 mm/s |
| | Aperture: | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm |
| | Total Time to Mark: | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min |
| | Mark Grade: | B | B | B | B | B | B |
| 6 - Gas Assist Laser Etch (GALE) | Current Setting: | | | | | | |
| | Frequency Setting: | | | | | | |
| | Speed Setting: | | | | | | |
| | Total Time to Mark: | | | | | | |
| | Mark Grade: | | | | | | |
| 7 - Laser Engrave | Power: | 55.7 W | 55.7 W | 55.7 W | 55.7 W | 55.7 W | 55.7 W |
| | Current Setting: | 20 A | 20 A | 20 A | 20 A | 20 A | 20 A |
| | Frequency Setting: | 20000 Hz | 20000 Hz | 20000 Hz | 20000 Hz | 20000 Hz | 20000 Hz |
| | Speed Setting: | 20 mm/s | 20 mm/s | 20 mm/s | 20 mm/s | 20 mm/s | 20 mm/s |
| | Aperture: | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm |
| | Total Time to Mark: | 1 min | 1 min | 1 min | 1 min | 1 min | 1 min |
| | Mark Grade: | B | B | B | B | B | B |
| 8 - Laser Induce Surface Improvement (LISI) | Power: | 3W to 120W | 3W to 120W | 3W to 120W | 3W to 120W | 3W to 120W | 3W to 120W |
| | Power: | 95% | 95% | 95% | 95% | 95% | 95% |
| | Frequency Setting: | 20000 Hz | 20000 Hz | 20000 Hz | 20000 Hz | 20000 Hz | 20000 Hz |
| | Speed Setting: | 30 mm/s | 30 mm/s | 30 mm/s | 30 mm/s | 30 mm/s | 30 mm/s |
| | Wavelength: | 1064 nm | 1064 nm | 1064 nm | 1064 nm | 1064 nm | 1064 nm |
| | Total Time to Mark: | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min |
| | Mark Grade: | B | B | B | B | B | B |
| 9 - Vibropeen | Tip: | | | | | | |
| | Applied Pressure: | | | | | | |
| | Total Time to Mark: | | | | | | |
| 10 - Impression Stamp | Applied Pressure: | Low | Medium | High | | | |
| | Total Time to Mark: | 0.5 min | 0.5 min | 0.5 min | | | |

Comments:

Coupons S1A were abrasive blasted to remove the discolored oxide layer prior to marking. MIL-STD-1504, ALUMINUM OXIDE, 180 GRIT OR FINER was used as a guide.

2-LSP: LLNL did not provide process documentation for each mark.

3-MM: SP did not provide process documentation for each mark.

6-GALE: UTSI did not provide process documentation for each mark.

8-LISI: UTSI did not provide process documentation for each mark.

| | | |
|---|---|---|
| Prepared: SLM | Checked: DLR | Date: 3/29/01 |

# DPM PROCESS DATA SHEET
## COUPON: S1A-05 to S1A-16 : S2A-01 to S2A-06

| DPM Process | Marking Process Data | S1A Marks | S2A Marks |
|---|---|---|---|
| 1 - Dot Peen | Stylus Configuration: | 30° | 30° |
| | Pressure Setting: | 100 psi | 100 psi |
| | Stylus to Substrate Gap: | 0.450 in | 0.450 in |
| | Cell Spacing: | 0.019 in | 0.019 in |
| | Total Time to Mark: | 3 min | 1 min |
| | Mark Grade: | B | B |
| 2 - LaserShot™ Peen | Fluence: | 200 J/cm2 | 200 J/cm2 |
| | Pulse Width: | 20 ns | 20 ns |
| | Wavelength: | 1053 nm | 1053 nm |
| | Rep Rate: | 1 Hz to 6 Hz | 1 Hz to 6 Hz |
| | Mark Size: | 8 mm | 8 mm |
| | Cell Size: | 0.57 mm | 0.57 mm |
| | Total Time to Mark: | 1.5 min | 1.5 min |
| | Mark Grade: | C | C |
| 3 - Micro-Mill | Tool: | Center Drill | Center Drill |
| | Tool Cut Rate: | 2 in/min | 2 in/min |
| | Tool RPM: | 8000 RPM | 8000 RPM |
| | Lubrication: | Brushed Oil | Brushed Oil |
| | Depth: | 0.027 in | 0.027 in |
| | Hole Spacing: | 0.034 in | 0.034 in |
| | Tip: | 0.031 in | 0.031 in |
| | Total Time to Mark: | 14 min | 14 min |
| | Mark Grade: | B | B |
| 4 - Laser Bond | Marking Material: | LMM-6000 | LMM-6000 |
| | Material Manufacturer: | DMC2 | DMC2 |
| | Power: | 4.7 W | 4.7 W |
| | Current Setting: | 18 A | 18 A |
| | Frequency Setting: | 0 Hz | 0 Hz |
| | Speed Setting: | 20 mm/s | 20 mm/s |
| | Aperture: | 1.2 mm | 1.2 mm |
| | Total Time to Mark: | 6 min | 4 min |
| | Mark Grade: | B | B |
| 5 - Laser Etch | Power: | 4 W | 4.2 W |
| | Current Setting: | 11:00 AM | 11:00 AM |
| | Frequency Setting: | 3000 Hz | 3000 Hz |
| | Speed Setting: | 20 mm/s | 20 mm/s |
| | Aperture: | 2.4 mm | 2.4 mm |
| | Total Time to Mark: | 6 min | 2 min |
| | Mark Grade: | B | B |
| 6 - Gas Assist Laser Etch (GALE) | Current Setting: | 95% | 95% |
| | Frequency Setting: | 20,000 Hz | 20,000 Hz |
| | Speed Setting: | 200 mm/s | 200 mm/s |
| | Total Time to Mark: | 1.5 min | 1.5 min |
| | Mark Grade: | B | B |
| 7 - Laser Engrave | Power: | 55.7 W | 55.7 W |
| | Current Setting: | 20 A | 20 A |
| | Frequency Setting: | 3000 Hz | 3000 Hz |
| | Speed Setting: | 15 mm/s | 15 mm/s |
| | Aperture: | 2.4 mm | 2.4 mm |
| | Total Time to Mark: | 7 min | 2 min |
| | Mark Grade: | B | B |
| 8 - Laser Induce Surface Improvement (LISI) | Power: | 3W to 120W | 3W to 120W |
| | Power: | 95% | 95% |
| | Frequency Setting: | 10000 Hz | 10000 Hz |
| | Speed Setting: | 50 mm/s | 50 mm/s |
| | Wavelength: | 1064 nm | 1064 nm |
| | Total Time to Mark: | 0.5 min | 0.5 min |
| | Mark Grade: | B | B |
| 9 - Vibropeen | Tip: | 0.0625 in | 0.0625 in |
| | Applied Pressure: | Low | Low |
| | Total Time to Mark: | 0.5 min | 0.5 min |
| 10 - Impression Stamp | Applied Pressure: | High | High |
| | Total Time to Mark: | 0.5 min | 0.5 min |

Comments:

Coupons S1A were abrasive blasted to remove the discolored oxide layer prior to marking.
MIL-STD-1504, ALUMINUM OXIDE, 180 GRIT OR FINER was used as a guide.
Coupon S1A-13 was lost during shipping.
9-V: Low pressure was applied in accordance with strut marking practices after heat treatment.
10-IS: High pressure was applied to mark the surface.
10-IS: Impression stamping is not an accepted marking process for struts after heat treatment.

| Prepared: SLM | Checked: DLR | Date: 3/29/01 |
|---|---|---|

# DPM PROCESS DATA SHEET
## COUPON: S1B-01

| DPM Process | DPM Process Data | Mark 1 | Mark 2 | Mark 3 | Mark 4 | Mark 5 | Mark 6 |
|---|---|---|---|---|---|---|---|
| 1 - Dot Peen | Stylus Configuration: | 30° | 30° | 30° | 30° | 30° | 30° |
| | Pressure Setting: | 80 psi | 80 psi | 80 psi | 80 psi | 80 psi | 80 psi |
| | Stylus to Substrate Gap: | 0.375 in | 0.375 in | 0.375 in | 0.375 in | 0.375 in | 0.375 in |
| | Cell Spacing: | 0.02 in | 0.0205 in | 0.0205 in | 0.0205 in | 0.0205 in | 0.0205 in |
| | Total Time to Mark: | 1 min | 1 min | 1 min | 1 min | 1 min | 1 min |
| | Mark Grade: | A | A | A | A | A | A |
| 2 - LaserShot™ Peen | Fluence: | 120 J/cm2 | 120 J/cm2 | 120 J/cm2 | 120 J/cm2 | 120 J/cm2 | 120 J/cm2 |
| | Pulse Width: | 20 ns | 20 ns | 20 ns | 20 ns | 20 ns | 20 ns |
| | Wavelength: | 1053 nm | 1053 nm | 1053 nm | 1053 nm | 1053 nm | 1053 nm |
| | Rep Rate: | 1 Hz to 6 Hz | 1 Hz to 6 Hz | 1 Hz to 6 Hz | 1 Hz to 6 Hz | 1 Hz to 6 Hz | 1 Hz to 6 Hz |
| | Mark Size: | 8 mm | 8 mm | 8 mm | 8 mm | 8 mm | 8 mm |
| | Cell Size: | 0.57 mm | 0.57 mm | 0.57 mm | 0.57 mm | 0.57 mm | 0.57 mm |
| | Total Time to Mark: | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min |
| | Mark Grade: | A | A | A | A | A | A |
| 3 - Micro-Mill | Tool: | Center Drill | Center Drill | | | | |
| | Tool Cut Rate: | 1.92 in/min | 1.92 in/min | | | | |
| | Tool RPM: | 8000 RPM | 8000 RPM | | | | |
| | Lubrication: | Brushed Oil | Brushed Oil | | | | |
| | Depth: | 0.027 in | 0.027 in | | | | |
| | Hole Spacing: | 0.034 in | 0.034 in | | | | |
| | Tip: | 0.031 in | 0.031 in | | | | |
| | Total Time to Mark: | 14 min | 14 min | | | | |
| | Mark Grade: | A | A | | | | |
| 4 - Laser Bond | Marking Material: | LMM-6000 | LMM-6000 | LMM-6000 | LMM-6000 | LMM-6000 | LMM-6000 |
| | Material Manufacturer: | DMC2 | DMC2 | DMC2 | DMC2 | DMC2 | DMC2 |
| | Power: | 3 W | 3.2 W | 3 W | 3.5 W | 2.7 W | 3.9 W |
| | Current Setting: | 17 A | 17 A | 17 A | 17 A | 16.5 A | 18 A |
| | Frequency Setting: | 0 Hz | 0 Hz | 0 Hz | 0 Hz | 0 Hz | 0 Hz |
| | Speed Setting: | 50 mm/s | 35 mm/s | 60 mm/s | 20 mm/s | 50 mm/s | 50 mm/s |
| | Aperture: | 1.2 mm | 1.2 mm | 1.2 mm | 1.2 mm | 1.2 mm | 1.2 mm |
| | Total Time to Mark: | 0.5 min | 0.5 min | 0.5 min | 1 min | 0.5 min | 0.5 min |
| | Mark Grade: | A | A | A | A | A | A |
| 5 - Laser Etch | Power: | 10.9 W | 4.9 W | 5.2 W | 2.2 W | 1.2 W | 9.6 W |
| | Current Setting: | 13.5 A | 11.0 A | 11.0 A | 10.0 A | 11.0 A | 13.0 A |
| | Frequency Setting: | 5000 Hz | 7000 Hz | 9000 Hz | 3000 Hz | 1000 Hz | 7000 Hz |
| | Speed Setting: | 20 mm/s | 20 mm/s | 20 mm/s | 15 mm/s | 20 mm/s | 40 mm/s |
| | Aperture: | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm |
| | Total Time to Mark: | 0.5 min | 1 min | 1 min | 1 min | 1 min | 0.5 min |
| | Mark Grade: | A | A | A | A | A | A |
| 6 - Gas Assist Laser Etch (GALE) | Current Setting: | 95% | 95% | | | | |
| | Frequency Setting: | 20,000 Hz | 20,000 Hz | | | | |
| | Speed Setting: | 200 mm/s | 200 mm/s | | | | |
| | Total Time to Mark: | 0.5 min | 0.5 min | | | | |
| | Mark Grade: | A | A | | | | |
| 7 - Laser Engrave | Power: | 55.7 W | 55.7 W | 55.7 W | 55.7 W | 55.7 W | 55.7 W |
| | Current Setting: | 20 A | 20 A | 20 A | 20 A | 20 A | 20 A |
| | Frequency Setting: | 20000 Hz | 20000 Hz | 20000 Hz | 20000 Hz | 20000 Hz | 20000 Hz |
| | Speed Setting: | 20 mm/s | 20 mm/s | 20 mm/s | 20 mm/s | 20 mm/s | 20 mm/s |
| | Aperture: | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm |
| | Total Time to Mark: | 1 min | 1 min | 1 min | 1 min | 1 min | 1 min |
| | Mark Grade: | B | B | B | B | B | B |
| 8 - Laser Induce Surface Improvement (LISI) | Power: | 3W to 120W | 3W to 120W | | | | |
| | Power: | 95% | 95% | | | | |
| | Frequency Setting: | 20000 Hz | 20000 Hz | | | | |
| | Speed Setting: | 30 mm/s | 30 mm/s | | | | |
| | Wavelength: | 1064 nm | 1064 nm | | | | |
| | Total Time to Mark: | 0.5 min | 0.5 min | | | | |
| | Mark Grade: | A | A | | | | |
| 9 - Vibropeen | Tip: | 0.0625 in | 0.0625 in | 0.0625 in | | | |
| | Applied Pressure: | Low | Medium | High | | | |
| | Total Time to Mark: | 0.5 min | 0.5 min | 0.5 min | | | |
| 10 - Impression Stamp | Applied Pressure: | | | | | | |
| | Total Time to Mark: | | | | | | |

Comments:

2-LSP: LLNL did not provide process documentation for each mark.

3-MM: SP did not provide process documentation for each mark.

6-GALE: UTSI did not provide process documentation for each mark.

8-LISI: UTSI did not provide process documentation for each mark.

| | | | |
|---|---|---|---|
| | Prepared: SLM | Checked: DLR | Date: 3/29/01 |

# DPM PROCESS DATA SHEET
## COUPON: S1B-02

| DPM Process | DPM Process Data | Mark 1 | Mark 2 | Mark 3 | Mark 4 | Mark 5 | Mark 6 |
|---|---|---|---|---|---|---|---|
| 1 - Dot Peen | Stylus Configuration: | 30° | 30° | 30° | 30° | 30° | 30° |
| | Pressure Setting: | 90 psi | 90 psi | 90 psi | 90 psi | 90 psi | 90 psi |
| | Stylus to Substrate Gap: | 0.425 in | 0.425 in | 0.425 in | 0.425 in | 0.425 in | 0.425 in |
| | Cell Spacing: | 0.02 in | 0.02 in | 0.02 in | 0.02 in | 0.02 in | 0.02 in |
| | Total Time to Mark: | 1 min | 1 min | 1 min | 1 min | 1 min | 1 min |
| | Mark Grade: | A | A | A | A | A | A |
| 2 - LaserShot™ Peen | Fluence: | | | | | | |
| | Pulse Width: | | | | | | |
| | Wavelength: | | | | | | |
| | Rep Rate: | | | | | | |
| | Mark Size: | | | | | | |
| | Cell Size: | | | | | | |
| | Total Time to Mark: | | | | | | |
| | Mark Grade: | | | | | | |
| 3 - Micro-Mill | Tool: | Center Drill | Center Drill | Center Drill | Center Drill | Center Drill | Center Drill |
| | Tool Cut Rate: | 1.92 in/min | 1.92 in/min | 1.92 in/min | 1.92 in/min | 1.92 in/min | 1.92 in/min |
| | Tool RPM: | 8000 RPM | 8000 RPM | 8000 RPM | 8000 RPM | 8000 RPM | 8000 RPM |
| | Lubrication: | Brushed Oil | Brushed Oil | Brushed Oil | Brushed Oil | Brushed Oil | Brushed Oil |
| | Depth: | 0.027 in | 0.027 in | 0.027 in | 0.027 in | 0.027 in | 0.027 in |
| | Hole Spacing: | 0.034 in | 0.034 in | 0.034 in | 0.034 in | 0.034 in | 0.034 in |
| | Tip: | 0.031 in | 0.031 in | 0.031 in | 0.031 in | 0.031 in | 0.031 in |
| | Total Time to Mark: | 14 min | 14 min | 14 min | 14 min | 14 min | 14 min |
| | Mark Grade: | A | A | A | A | A | A |
| 4 - Laser Bond | Marking Material: | LMM-6000 | LMM-6000 | LMM-6000 | LMM-6000 | LMM-6000 | LMM-6000 |
| | Material Manufacturer: | DMC2 | DMC2 | DMC2 | DMC2 | DMC2 | DMC2 |
| | Power: | 5.4 W | 1.7 W | 4.6 W | 5.5 W | 1.3 W | 1.6 W |
| | Current Setting: | 20 A | 15 A | 20 A | 20 A | 15 A | 15 A |
| | Frequency Setting: | 0 Hz | 0 Hz | 0 Hz | 0 Hz | 0 Hz | 0 Hz |
| | Speed Setting: | 20 mm/s | 20 mm/s | 40 mm/s | 10 mm/s | 10 mm/s | 20 mm/s |
| | Aperture: | 1.2 mm | 1.2 mm | 1.2 mm | 1.2 mm | 1.2 mm | 1.2 mm |
| | Total Time to Mark: | 0.5 min | 0.5 min | 0.5 min | 1 min | 1.0 min | 0.5 min |
| | Mark Grade: | A | B | A | B | B | B |
| 5 - Laser Etch | Power: | 3.8 W | 6.4 W | 9.6 W | 5.7 W | 7.8 W | 5.6 W |
| | Current Setting: | 11.0 A | 12.0 A | 13.0 A | 12.0 A | 12.0 A | 13.0 A |
| | Frequency Setting: | 3000 Hz | 4000 Hz | 5000 Hz | 3000 Hz | 5000 Hz | 2000 Hz |
| | Speed Setting: | 20 mm/s | 20 mm/s | 20 mm/s | 20 mm/s | 20 mm/s | 20 mm/s |
| | Aperture: | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm |
| | Total Time to Mark: | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min |
| | Mark Grade: | A | A | B | A | A | B |
| 6 - Gas Assist Laser Etch (GALE) | Current Setting: | 95% | | | | | |
| | Frequency Setting: | 20,000 Hz | | | | | |
| | Speed Setting: | 200 mm/s | | | | | |
| | Total Time to Mark: | 0.5 min | | | | | |
| | Mark Grade: | A | | | | | |
| 7 - Laser Engrave | Power: | 55.7 W | 55.7 W | 55.7 W | 55.7 W | 55.7 W | 55.7 W |
| | Current Setting: | 20 A | 20 A | 20 A | 20 A | 20 A | 20 A |
| | Frequency Setting: | 20000 Hz | 20000 Hz | 20000 Hz | 20000 Hz | 20000 Hz | 20000 Hz |
| | Speed Setting: | 20 mm/s | 20 mm/s | 20 mm/s | 20 mm/s | 20 mm/s | 20 mm/s |
| | Aperture: | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm |
| | Total Time to Mark: | 1 min | 1 min | 1 min | 1 min | 1 min | 1 min |
| | Mark Grade: | B | B | B | B | B | B |
| 8 - Laser Induce Surface Improvement (LISI) | Power: | 3W to 120W | | | | | |
| | Power: | 95% | | | | | |
| | Frequency Setting: | 20000 Hz | | | | | |
| | Speed Setting: | 30 mm/s | | | | | |
| | Wavelength: | 1064 nm | | | | | |
| | Total Time to Mark: | 0.5 min | | | | | |
| | Mark Grade: | A | | | | | |
| 9 - Vibropeen | Tip: | 0.0625 in | 0.0625 in | 0.0625 in | | | |
| | Applied Pressure: | Low | Medium | High | | | |
| | Total Time to Mark: | 0.5 min | 0.5 min | 0.5 min | | | |
| 10 - Impression Stamp | Applied Pressure: | | | | | | |
| | Total Time to Mark: | | | | | | |

Comments:

2-LSP: LLNL did not provide process documentation for each mark.

3-MM: SP did not provide process documentation for each mark.

6-GALE: UTSI did not provide process documentation for each mark.

8-LISI: UTSI did not provide process documentation for each mark.

| | | | |
|---|---|---|---|
| | Prepared: SLM | Checked: DLR | Date: 3/29/01 |

# DPM PROCESS DATA SHEET
## COUPON: S1B-03

| DPM Process | DPM Process Data | Mark 1 | Mark 2 | Mark 3 | Mark 4 | Mark 5 | Mark 6 |
|---|---|---|---|---|---|---|---|
| 1 - Dot Peen | Stylus Configuration: | 30° | 30° | 30° | 30° | 30° | 30° |
| | Pressure Setting: | 80 psi | 80 psi | 80 psi | 80 psi | 80 psi | 80 psi |
| | Stylus to Substrate Gap: | 0.375 in | 0.375 in | 0.375 in | 0.375 in | 0.375 in | 0.375 in |
| | Cell Spacing: | 0.02 in | 0.0205 in | 0.0205 in | 0.0205 in | 0.0205 in | 0.0205 in |
| | Total Time to Mark: | 1 min | 1 min | 1 min | 1 min | 1 min | 1 min |
| | Mark Grade: | A | A | A | A | A | A |
| 2 - LaserShot™ Peen | Fluence: | 120 J/cm2 | 120 J/cm2 | 120 J/cm2 | 120 J/cm2 | 120 J/cm2 | 120 J/cm2 |
| | Pulse Width: | 20 ns | 20 ns | 20 ns | 20 ns | 20 ns | 20 ns |
| | Wavelength: | 1053 nm | 1053 nm | 1053 nm | 1053 nm | 1053 nm | 1053 nm |
| | Rep Rate: | 1 Hz to 6 Hz | 1 Hz to 6 Hz | 1 Hz to 6 Hz | 1 Hz to 6 Hz | 1 Hz to 6 Hz | 1 Hz to 6 Hz |
| | Mark Size: | 8 mm | 8 mm | 8 mm | 8 mm | 8 mm | 8 mm |
| | Cell Size: | 0.57 mm | 0.57 mm | 0.57 mm | 0.57 mm | 0.57 mm | 0.57 mm |
| | Total Time to Mark: | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min |
| | Mark Grade: | B | B | B | B | B | B |
| 3 - Micro-Mill | Tool: | Center Drill | Center Drill | Center Drill | Center Drill | Center Drill | Center Drill |
| | Tool Cut Rate: | 1.92 in/min | 1.92 in/min | 1.92 in/min | 1.92 in/min | 1.92 in/min | 1.92 in/min |
| | Tool RPM: | 8000 RPM | 8000 RPM | 8000 RPM | 8000 RPM | 8000 RPM | 8000 RPM |
| | Lubrication: | Brushed Oil | Brushed Oil | Brushed Oil | Brushed Oil | Brushed Oil | Brushed Oil |
| | Depth: | 0.027 in | 0.027 in | 0.027 in | 0.027 in | 0.027 in | 0.027 in |
| | Hole Spacing: | 0.034 in | 0.034 in | 0.034 in | 0.034 in | 0.034 in | 0.034 in |
| | Tip: | 0.031 in | 0.031 in | 0.031 in | 0.031 in | 0.031 in | 0.031 in |
| | Total Time to Mark: | 14 min | 14 min | 14 min | 14 min | 14 min | 14 min |
| | Mark Grade: | A | A | A | A | A | A |
| 4 - Laser Bond | Marking Material: | LMM-6000 | LMM-6000 | LMM-6000 | LMM-6000 | LMM-6000 | LMM-6000 |
| | Material Manufacturer: | DMC2 | DMC2 | DMC2 | DMC2 | DMC2 | DMC2 |
| | Power: | 3 W | 3.2 W | 3 W | 3.5 W | 2.7 W | 3.9 W |
| | Current Setting: | 17 A | 17 A | 17 A | 17 A | 16.5 A | 18 A |
| | Frequency Setting: | 0 Hz | 0 Hz | 0 Hz | 0 Hz | 0 Hz | 0 Hz |
| | Speed Setting: | 50 mm/s | 35 mm/s | 60 mm/s | 20 mm/s | 50 mm/s | 50 mm/s |
| | Aperture: | 1.2 mm | 1.2 mm | 1.2 mm | 1.2 mm | 1.2 mm | 1.2 mm |
| | Total Time to Mark: | 0.5 min | 0.5 min | 0.5 min | 1 min | 0.5 min | 0.5 min |
| | Mark Grade: | A | A | B | A | B | A |
| 5 - Laser Etch | Power: | 10.9 W | 4.9 W | 5.2 W | 2.2 W | 1.2 W | 9.6 W |
| | Current Setting: | 13.5 A | 11.0 A | 11.0 A | 10.0 A | 11.0 A | 13.0 A |
| | Frequency Setting: | 5000 Hz | 7000 Hz | 9000 Hz | 3000 Hz | 1000 Hz | 7000 Hz |
| | Speed Setting: | 30 mm/s | 20 mm/s | 20 mm/s | 15 mm/s | 20 mm/s | 40 mm/s |
| | Aperture: | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm |
| | Total Time to Mark: | 0.5 min | 1 min | 1 min | 1 min | 1 min | 0.5 min |
| | Mark Grade: | B | A | A | A | A | B |
| 6 - Gas Assist Laser Etch (GALE) | Current Setting: | 95% | 95% | | | | |
| | Frequency Setting: | 20,000 Hz | 20,000 Hz | | | | |
| | Speed Setting: | 200 mm/s | 200 mm/s | | | | |
| | Total Time to Mark: | 0.5 min | 0.5 min | | | | |
| | Mark Grade: | A | A | | | | |
| 7 - Laser Engrave | Power: | 55.7 W | 55.7 W | 55.7 W | 55.7 W | 55.7 W | 55.7 W |
| | Current Setting: | 20 A | 20 A | 20 A | 20 A | 20 A | 20 A |
| | Frequency Setting: | 20000 Hz | 20000 Hz | 20000 Hz | 20000 Hz | 20000 Hz | 20000 Hz |
| | Speed Setting: | 20 mm/s | 20 mm/s | 20 mm/s | 20 mm/s | 20 mm/s | 20 mm/s |
| | Aperture: | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm |
| | Total Time to Mark: | 1 min | 1 min | 1 min | 1 min | 1 min | 1 min |
| | Mark Grade: | B | B | B | B | B | B |
| 8 - Laser Induce Surface Improvement (LISI) | Power: | | | | | | |
| | Power: | | | | | | |
| | Frequency Setting: | | | | | | |
| | Speed Setting: | | | | | | |
| | Wavelength: | | | | | | |
| | Total Time to Mark: | | | | | | |
| | Mark Grade: | | | | | | |
| 9 - Vibropeen | Tip: | | | | | | |
| | Applied Pressure: | | | | | | |
| | Total Time to Mark: | | | | | | |
| 10 - Impression Stamp | Applied Pressure: | Low | Medium | High | | | |
| | Total Time to Mark: | 0.5 min | 0.5 min | 0.5 min | | | |

Comments:

2-LSP: LLNL did not provide process documentation for each mark.

3-MM: SP did not provide process documentation for each mark.

6-GALE: UTSI did not provide process documentation for each mark.

8-LISI: UTSI did not provide process documentation for each mark.

| | | | |
|---|---|---|---|
| | Prepared: SLM | Checked: DLR | Date: 3/29/01 |

# DPM PROCESS DATA SHEET
## COUPON: S1B-04

| DPM Process | DPM Process Data | Mark 1 | Mark 2 | Mark 3 | Mark 4 | Mark 5 | Mark 6 |
|---|---|---|---|---|---|---|---|
| 1 - Dot Peen | Stylus Configuration: | 30° | 30° | 30° | 30° | 30° | 30° |
| | Pressure Setting: | 90 psi | 90 psi | 90 psi | 90 psi | 90 psi | 90 psi |
| | Stylus to Substrate Gap: | 0.425 in | 0.425 in | 0.425 in | 0.425 in | 0.425 in | 0.425 in |
| | Cell Spacing: | 0.02 in | 0.0205 in | 0.0205 in | 0.0205 in | 0.0205 in | 0.0205 in |
| | Total Time to Mark: | 1 min | 1 min | 1 min | 1 min | 1 min | 1 min |
| | Mark Grade: | A | A | A | A | A | A |
| 2 - LaserShot™ Peen | Fluence: | 120 J/cm2 | 120 J/cm2 | 120 J/cm2 | 120 J/cm2 | 120 J/cm2 | 120 J/cm2 |
| | Pulse Width: | 20 ns | 20 ns | 20 ns | 20 ns | 20 ns | 20 ns |
| | Wavelength: | 1053 nm | 1053 nm | 1053 nm | 1053 nm | 1053 nm | 1053 nm |
| | Rep Rate: | 1 Hz to 6 Hz | 1 Hz to 6 Hz | 1 Hz to 6 Hz | 1 Hz to 6 Hz | 1 Hz to 6 Hz | 1 Hz to 6 Hz |
| | Mark Size: | 8 mm | 8 mm | 8 mm | 8 mm | 8 mm | 8 mm |
| | Cell Size: | 0.57 mm | 0.57 mm | 0.57 mm | 0.57 mm | 0.57 mm | 0.57 mm |
| | Total Time to Mark: | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min |
| | Mark Grade: | A | A | A | A | A | A |
| 3 - Micro-Mill | Tool: | Center Drill | Center Drill | Center Drill | Center Drill | Center Drill | Center Drill |
| | Tool Cut Rate: | 1.92 in/min | 1.92 in/min | 1.92 in/min | 1.92 in/min | 1.92 in/min | 1.92 in/min |
| | Tool RPM: | 8000 RPM | 8000 RPM | 8000 RPM | 8000 RPM | 8000 RPM | 8000 RPM |
| | Lubrication: | Brushed Oil | Brushed Oil | Brushed Oil | Brushed Oil | Brushed Oil | Brushed Oil |
| | Depth: | 0.027 in | 0.027 in | 0.027 in | 0.027 in | 0.027 in | 0.027 in |
| | Hole Spacing: | 0.034 in | 0.034 in | 0.034 in | 0.034 in | 0.034 in | 0.034 in |
| | Tip: | 0.031 in | 0.031 in | 0.031 in | 0.031 in | 0.031 in | 0.031 in |
| | Total Time to Mark: | 14 min | 14 min | 14 min | 14 min | 14 min | 14 min |
| | Mark Grade: | A | A | A | A | A | A |
| 4 - Laser Bond | Marking Material: | LMM-6000 | LMM-6000 | LMM-6000 | LMM-6000 | LMM-6000 | LMM-6000 |
| | Material Manufacturer: | DMC2 | DMC2 | DMC2 | DMC2 | DMC2 | DMC2 |
| | Power: | 5.4 W | 1.7 W | 4.6 W | 5.5 W | 1.3 W | 1.6 W |
| | Current Setting: | 20 A | 15 A | 20 A | 20 A | 15 A | 15 A |
| | Frequency Setting: | 0 Hz | 0 Hz | 0 Hz | 0 Hz | 0 Hz | 0 Hz |
| | Speed Setting: | 20 mm/s | 20 mm/s | 40 mm/s | 10 mm/s | 10 mm/s | 5 mm/s |
| | Aperture: | 1.2 mm | 1.2 mm | 1.2 mm | 1.2 mm | 1.2 mm | 1.2 mm |
| | Total Time to Mark: | 0.5 min | 0.5 min | 0.5 min | 1 min | 1 min | 2.0 min |
| | Mark Grade: | A | B | A | B | B | B |
| 5 - Laser Etch | Power: | 3.8 W | 6.4 W | 9.6 W | 5.7 W | 7.8 W | 5.6 W |
| | Current Setting: | 11.0 A | 12.0 A | 13.0 A | 12.0 A | 12.0 A | 13.0 A |
| | Frequency Setting: | 3000 Hz | 4000 Hz | 5000 Hz | 3000 Hz | 5000 Hz | 2000 Hz |
| | Speed Setting: | 20 mm/s | 20 mm/s | 20 mm/s | 20 mm/s | 20 mm/s | 20 mm/s |
| | Aperture: | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm |
| | Total Time to Mark: | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min |
| | Mark Grade: | A | A | B | A | A | B |
| 6 - Gas Assist Laser Etch (GALE) | Current Setting: | 95% | | | | | |
| | Frequency Setting: | 20,000 Hz | | | | | |
| | Speed Setting: | 200 mm/s | | | | | |
| | Total Time to Mark: | 0.5 min | | | | | |
| | Mark Grade: | A | | | | | |
| 7 - Laser Engrave | Power: | 55.7 W | 55.7 W | 55.7 W | 55.7 W | 55.7 W | 55.7 W |
| | Current Setting: | 20 A | 20 A | 20 A | 20 A | 20 A | 20 A |
| | Frequency Setting: | 20000 Hz | 20000 Hz | 20000 Hz | 20000 Hz | 20000 Hz | 20000 Hz |
| | Speed Setting: | 20 mm/s | 20 mm/s | 20 mm/s | 20 mm/s | 20 mm/s | 20 mm/s |
| | Aperture: | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm | 2.4 mm |
| | Total Time to Mark: | 1 min | 1 min | 1 min | 1 min | 1 min | 1 min |
| | Mark Grade: | B | B | B | B | B | B |
| 8 - Laser Induce Surface Improvement (LISI) | Power: | 3W to 120W | 3W to 120W | 3W to 120W | 3W to 120W | 3W to 120W | 3W to 120W |
| | Power: | 95% | 95% | 95% | 95% | 95% | 95% |
| | Frequency Setting: | 20000 Hz | 20000 Hz | 20000 Hz | 20000 Hz | 20000 Hz | 20000 Hz |
| | Speed Setting: | 30 mm/s | 30 mm/s | 30 mm/s | 30 mm/s | 30 mm/s | 30 mm/s |
| | Wavelength: | 1064 nm | 1064 nm | 1064 nm | 1064 nm | 1064 nm | 1064 nm |
| | Total Time to Mark: | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min | 0.5 min |
| | Mark Grade: | A | A | A | A | A | A |
| 9 - Vibropeen | Tip: | 0.0625 in | 0.0625 in | 0.0625 in | | | |
| | Applied Pressure: | Low | Medium | High | | | |
| | Total Time to Mark: | 0.5 min | 0.5 min | 0.5 min | | | |
| 10 - Impression Stamp | Applied Pressure: | | | | | | |
| | Total Time to Mark: | | | | | | |

Comments:

2-LSP: LLNL did not provide process documentation for each mark.

3-MM: SP did not provide process documentation for each mark.

6-GALE: UTSI did not provide process documentation for each mark.

8-LISI: UTSI did not provide process documentation for each mark.

| | | |
|---|---|---|
| Prepared: SLM | Checked: DLR | Date: 3/29/01 |

# DPM PROCESS DATA SHEET
## COUPON: S1B-05 to S1B-16 : S2B-01 to S2B-06

| DPM Process | Marking Process Data | S1B Marks | S2B Marks |
|---|---|---|---|
| 1 - Dot Peen | Stylus Configuration: | 30° | 30° |
| | Pressure Setting: | 100 psi | 100 psi |
| | Stylus to Substrate Gap: | 0.450 in | 0.450 in |
| | Cell Spacing: | 0.019 in | 0.019 in |
| | Total Time to Mark: | 3 min | 1 min |
| | Mark Grade: | A | A |
| 2 - LaserShot™ Peen | Fluence: | 200 J/cm2 | 200 J/cm2 |
| | Pulse Width: | 20 ns | 20 ns |
| | Wavelength: | 1053 nm | 1053 nm |
| | Rep Rate: | 1 Hz to 6 Hz | 1 Hz to 6 Hz |
| | Mark Size: | 8 mm | 8 mm |
| | Cell Size: | 0.57 mm | 0.57 mm |
| | Total Time to Mark: | 1.5 min | 1.5 min |
| | Mark Grade: | A | A |
| 3 - Micro-Mill | Tool: | Center Drill | Center Drill |
| | Tool Cut Rate: | 2 in/min | 2 in/min |
| | Tool RPM: | 8000 RPM | 8000 RPM |
| | Lubrication: | Brushed Oil | Brushed Oil |
| | Depth: | 0.027 in | 0.027 in |
| | Hole Spacing: | 0.034 in | 0.034 in |
| | Tip: | 0.031 in | 0.031 in |
| | Total Time to Mark: | 14 min | 14 min |
| | Mark Grade: | A | A |
| 4 - Laser Bond | Marking Material: | LMM-6000 | LMM-6000 |
| | Material Manufacturer: | DMC2 | DMC2 |
| | Power: | 4.7 W | 4.7 W |
| | Current Setting: | 18 A | 18 A |
| | Frequency Setting: | 0 Hz | 0 Hz |
| | Speed Setting: | 20 mm/s | 20 mm/s |
| | Aperture: | 1.2 mm | 1.2 mm |
| | Total Time to Mark: | 6 min | 4 min |
| | Mark Grade: | A | A |
| 5 - Laser Etch | Power: | 4 W | 4.2 W |
| | Current Setting: | 11.00 A | 11.00 A |
| | Frequency Setting: | 3000 Hz | 3000 Hz |
| | Speed Setting: | 20 mm/s | 20 mm/s |
| | Aperture: | 2.4 mm | 2.4 mm |
| | Total Time to Mark: | 6 min | 2 min |
| | Mark Grade: | A | A |
| 6 - Gas Assist Laser Etch (GALE) | Current Setting: | 95% | 95% |
| | Frequency Setting: | 20,000 Hz | 20,000 Hz |
| | Speed Setting: | 200 mm/s | 200 mm/s |
| | Total Time to Mark: | 1.5 min | 1.5 min |
| | Mark Grade: | A | A |
| 7 - Laser Engrave | Power: | 55.7 W | 55.7 W |
| | Current Setting: | 20 A | 20 A |
| | Frequency Setting: | 3000 Hz | 3000 Hz |
| | Speed Setting: | 15 mm/s | 15 mm/s |
| | Aperture: | 2.4 mm | 2.4 mm |
| | Total Time to Mark: | 7 min | 2 min |
| | Mark Grade: | B | B |
| 8 - Laser Induce Surface Improvement (LISI) | Power: | 3W to 120W | 3W to 120W |
| | Power: | 95% | 95% |
| | Frequency Setting: | 10000 Hz | 10000 Hz |
| | Speed Setting: | 50 mm/s | 50 mm/s |
| | Wavelength: | 1064 nm | 1064 nm |
| | Total Time to Mark: | 0.5 min | 0.5 min |
| | Mark Grade: | A | A |
| 9 - Vibropeen | Tip: | 0.0625 in | 0.0625 in |
| | Applied Pressure: | Low | Low |
| | Total Time to Mark: | 0.5 min | 0.5 min |
| 10 - Impression Stamp | Applied Pressure: | High | High |
| | Total Time to Mark: | 0.5 min | 0.5 min |

Comments:

Coupons S2B-01 and S2B-06 were lost during shipping.

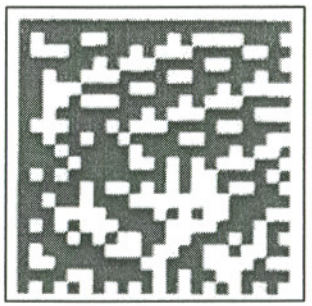
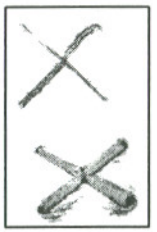
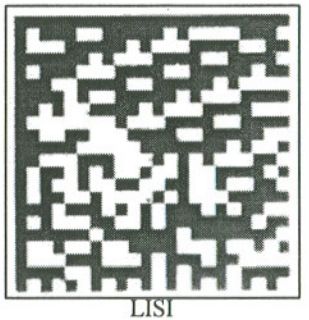
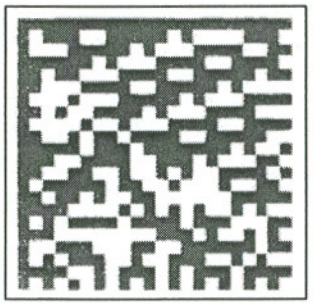
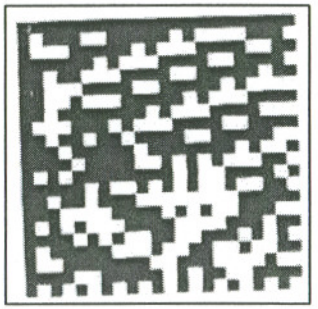
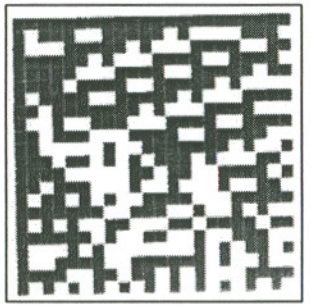
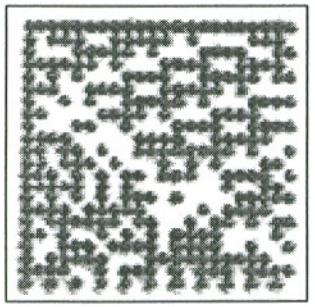
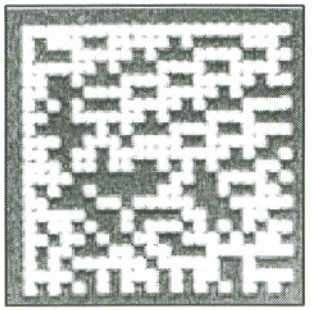
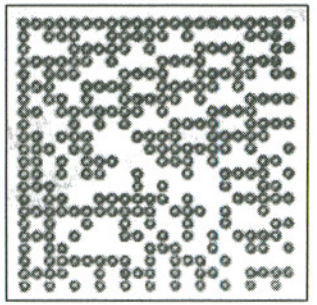
9-V: High pressure was applied in accordance with strut marking practices before heat treatment.

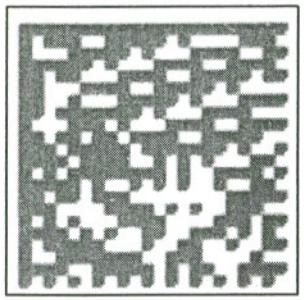
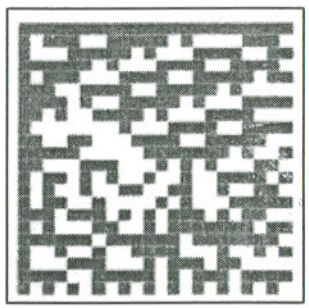
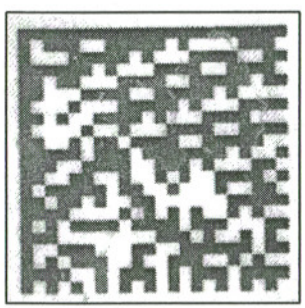
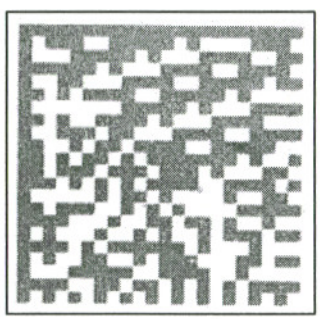
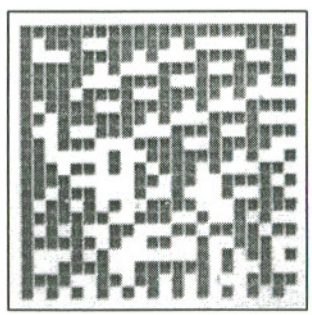
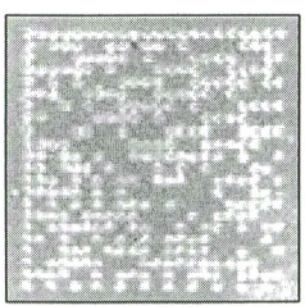
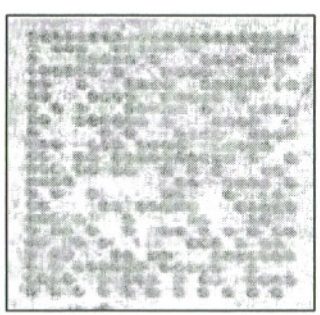
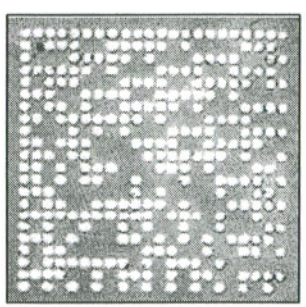
10-IS: High pressure was applied in accordance with strut marking practices before heat treatment.

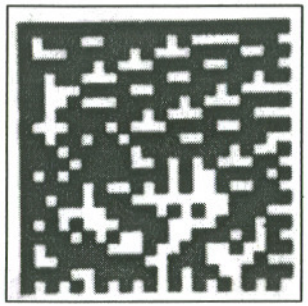
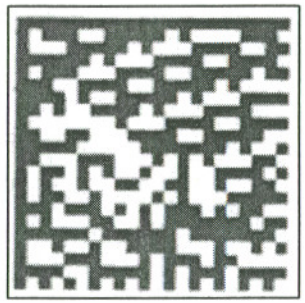
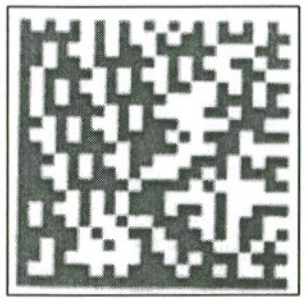
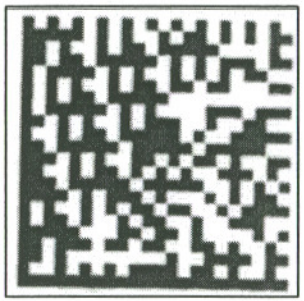
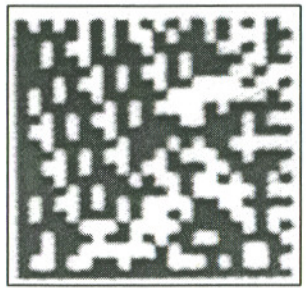
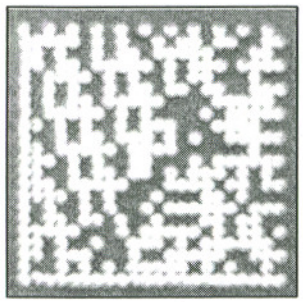
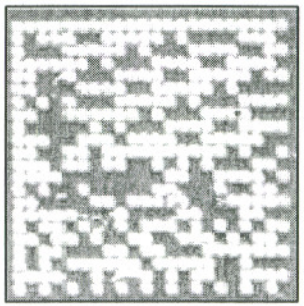
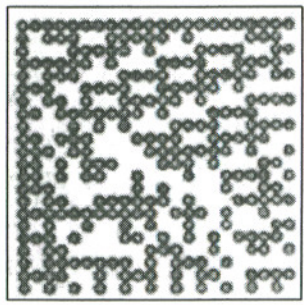
| Prepared: SLM | Checked: DLR | Date: 3/29/01 |
|---|---|---|

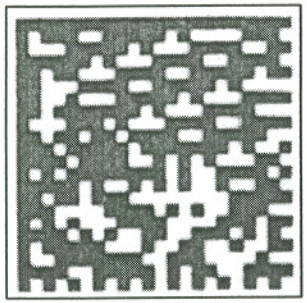
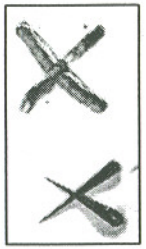
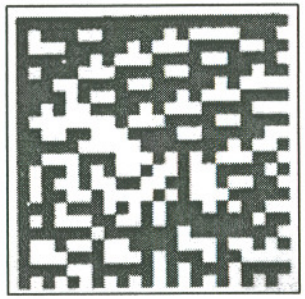
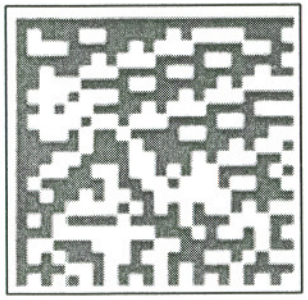
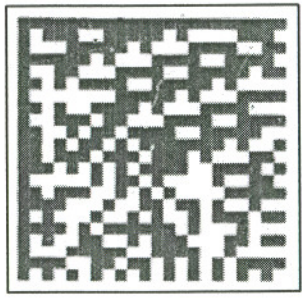
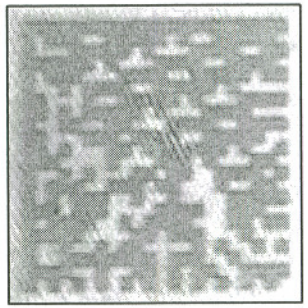
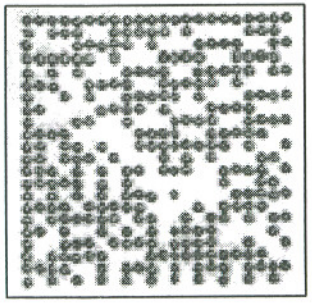
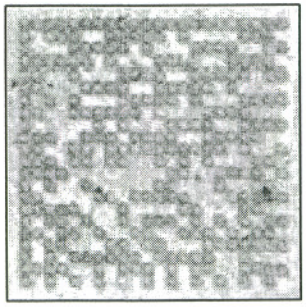
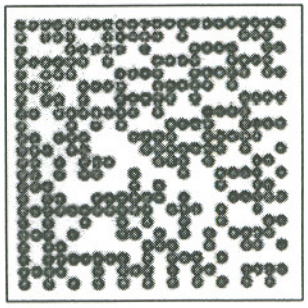
# APPENDIX C

# MARKING PHOTOGRAPHS

| DMx Auto ID+ Fixed Station Reader Optical Images | Coupon A1A | Mark |
|---|---|---|
|  Laser Engrave |  Vibropeen – Steel Stamp |  LISI |
|  Laser Bond |  Laser Etch |  GALE |
|  Dot Peen |  Lasershot™ Peen |  Micro-Mill |

| DMx Auto ID+ Fixed Station Reader Optical Images | Coupon S1A | Mark |
|---|---|---|
|  Laser Engrave | Vibropeen – Steel Stamp |  LISI |
|  Laser Bond |  Laser Etch |  GALE |
|  Dot Peen |  Lasershot™ Peen |  Micro-Mill |

| DMx Auto ID+ Fixed Station Reader Optical Images | Coupon S1B | Mark – Before Heat Treat |
|---|---|---|
|  Laser Engrave | Vibropeen – Steel Stamp |  LISI |
|  Laser Bond |  Laser Etch |  GALE |
|  Dot Peen |  Lasershot™ Peen |  Micro-Mill |

| DMx Auto ID+ Fixed Station Reader Optical Images | Coupon S1B | Mark – After Heat Treat |
|---|---|---|
|  Laser Engrave |  Vibropeen – Steel Stamp |  LISI |
|  Laser Bond |  Laser Etch |  GALE |
|  Dot Peen |  Lasershot™ Peen |  Micro-Mill |

# APPENDIX D

# PREVIOUS TEST DATA

# APPENDIX D

| Item | Source | Document Number | Date | Document Title |
|---|---|---|---|---|
| 1 | Pratt & Whitney | Lab Test Report 23211 | December 24, 1980 | Metallurgical Evaluation of Laser Marking on PWA 1422 1st Stage Turbine Blades |
| 2 | Rockwell International | NASA Special Task Assignment 168-R1 | May 11, 1987 | Vericode Machine-Readable Symbology Technical Evaluation |
| 3 | NASA MSFC | Program Report SSD92-M-0013 | December 21, 1991 | Vericode Automatic Identification System Evaluation Summary Report |
| 4 | Rockwell International | Summary Report SSD92-M-0019 | February 20, 1992 | Vericode Automatic Identification System Evaluation Summary Report |
| 5 | Rockwell International | Lab Test Report 240-1234 | April 1, 1992 | Analysis of Vericode Marked Tile |
| 6 | Rockwell International | Lab Test Report PTN 027937 | September 17, 1992 | Evaluation of Laser Marked Vericodes on Turbine Blades |
| 7 | Rockwell International | Lab Test Report PTN 027940 | September 24, 1992 | Evaluation of Laser Marked Ti-6Al-4V |
| 8 | Rockwell International | Letter 284-202-92-079 | November 16, 1992 | Preliminary Evaluation of Laser Marked Mar-M-246 and Ti-6Al-4V |
| 9 | NASA MSFC | Program Report SSD92-M-0024 | April 23, 1993 | Vericode Symbol Automatic Identification System Marking Test Program |
| 10 | NASA MSFC | Program Report SSD93-M-0029 | May 4, 1993 | Vericode Symbol Automatic Identification System Marking Test Program |
| 11 | Rockwell International | Lab Test Report 6158-2470 | August 1, 1993 | Evaluation of Vericode Laser Marked Materials |
| 12 | Ohio University | Lab Test Report 93-SL161 | September 1, 1993 | Data Matrix and PDF417 Data Integrity Test |
| 13 | Rockwell International | Preliminary Screening Tests NAS8-40000 | December 1, 1993 | High Cycle Fatigue Testing of Selected Materials Marked with Vericode Symbols |
| 14 | Rockwell International | Letter 93MA4416 | January 6, 1994 | Integration of Automated Part Identification (API) into the Configuration Verification and Accounting System |
| 15 | Pratt & Whitney | Government Engine Business Letter | March 7, 1995 | Compressed Symbology Marking for SSME Parts |
| 16 | Rockwell International | Letter 284-200-95-155 | July 19, 1995 | Results of Vericode Marking Test Program |
| 17 | University of Tennessee Space Institute | Letter SRC-97-163 | January 5, 1998 | Laser Settings |
| 18 | Ohio University | Executive Summary 99-28 | January 12, 1998 | Data Matrix And PDF 417 Data Integrity Test |
| 19 | University of Tennessee Space Institute | CiMatrix Clearcoat Testing Report | March 31, 1998 | Wear and Corrosion Testing of Coated Laser Marks on Anodized Aluminum |
| 20 | United States Coast Guard | Report DTCG38-97-C-300004 | June 26, 1998 | Aircraft Flight Critical Part Verification System Final Report |
| 21 | Cerdec | Letter SRC01-051 | December 19, 2000 | Height of LMM-6000 Laser Marks |
| 22 | Cerdec | LLM Test Results | January 3, 2001 | Physical Testing of LMM-6000 Laser Marks |
| 23 | Lawrence Livermore National Laboratory | Letter SRC01-052 | January 8, 2001 | Test Data for Laser Peening on Various Materials |
| 24 | RVSI Acuity CiMatrix | Email/Letter | January 31, 2001 | Photo Process, Electro-Chemical Marking Evaluation. |