A2A COUPON

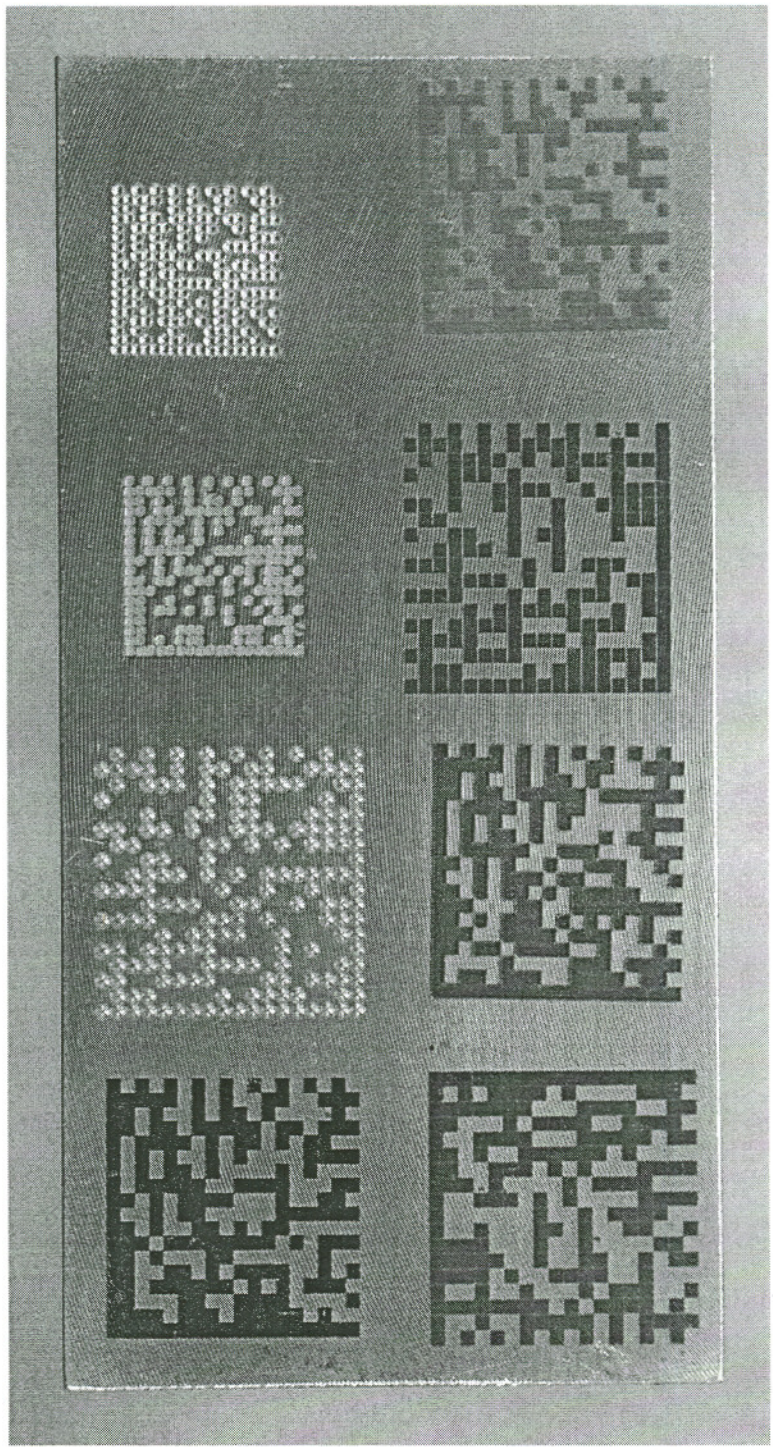


Figure A2A.0: Optical Image of Coupon A2A (~2X)

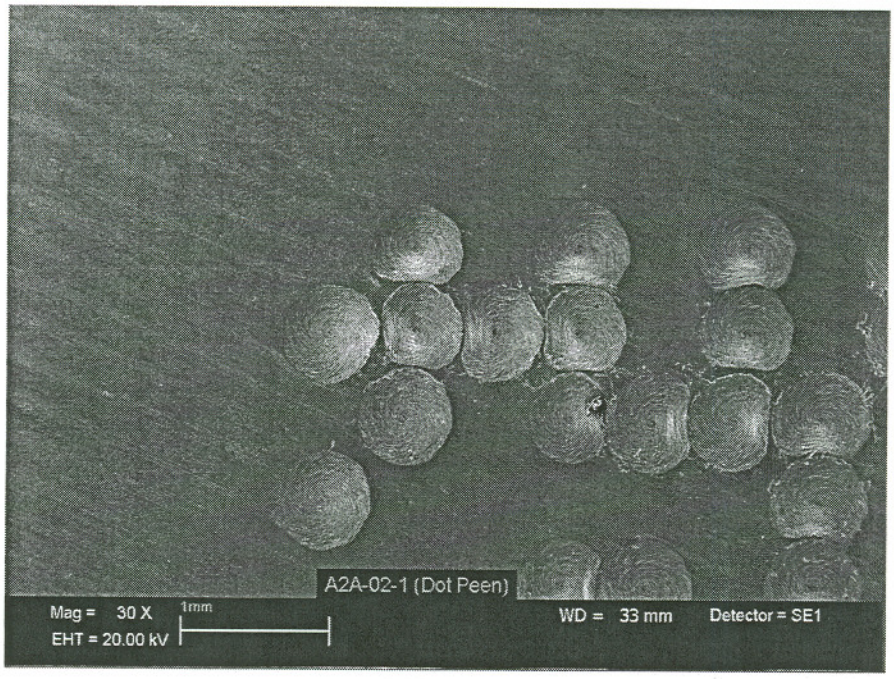


Figure A2A.1.1: SEM Surface Image of Dot Peen Cells (~30X)

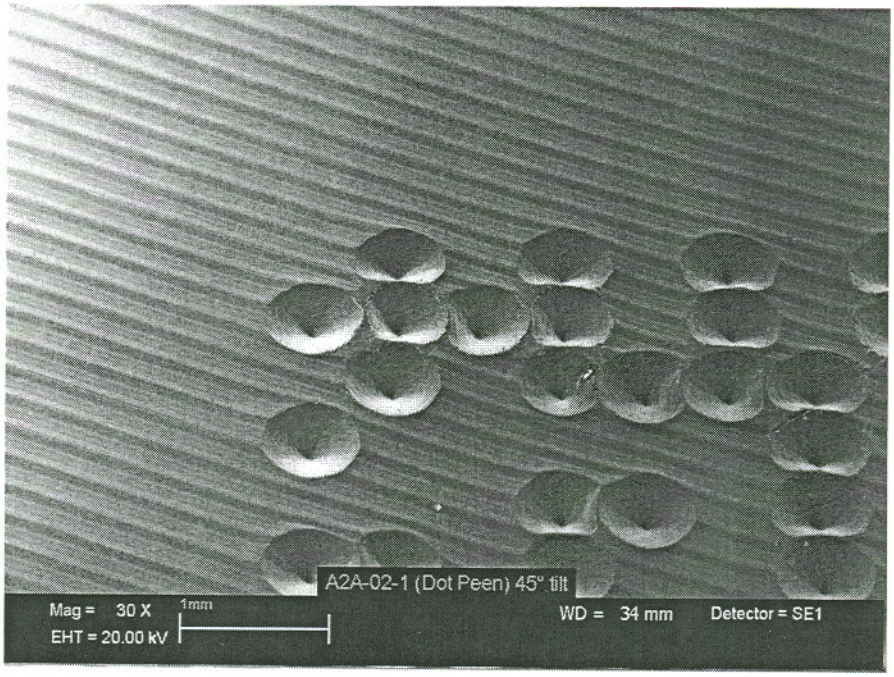


Figure A2A.1.2: SEM Surface Image of Dot Peen Cells at 45° Tilt (~30X)

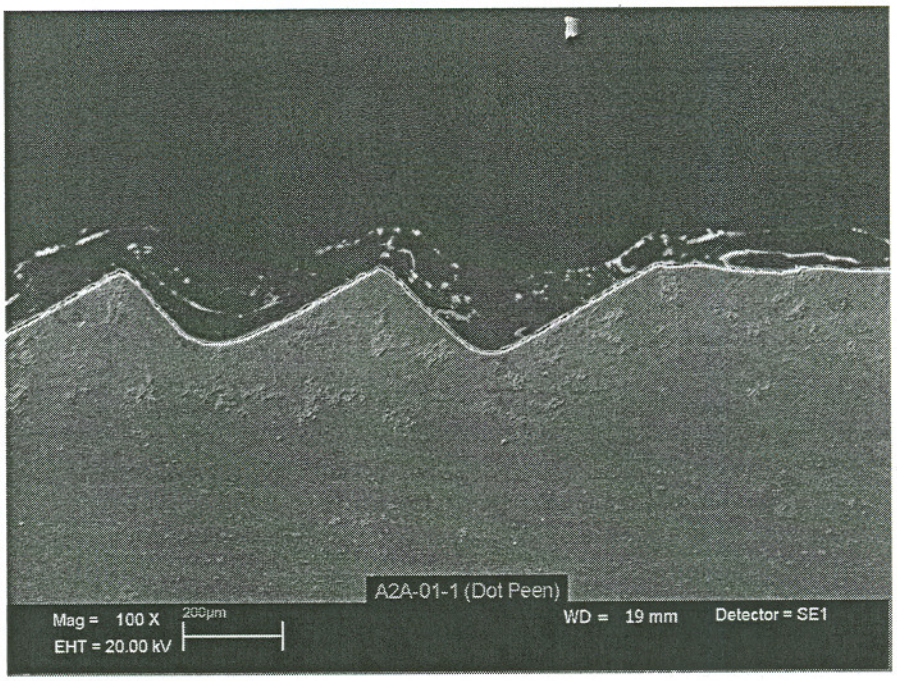


Figure A2A.1.3. SEM Cross Section Image of Dot Peen Cells (~100X)

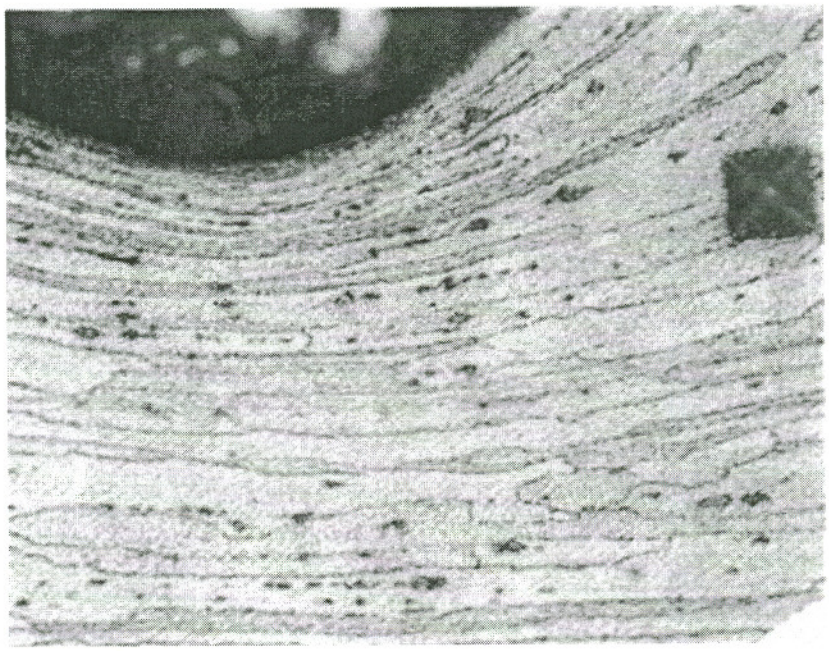


Figure A2A.1.4. Optical Cross Section Image of Etched Dot Peen Cell (~500X)

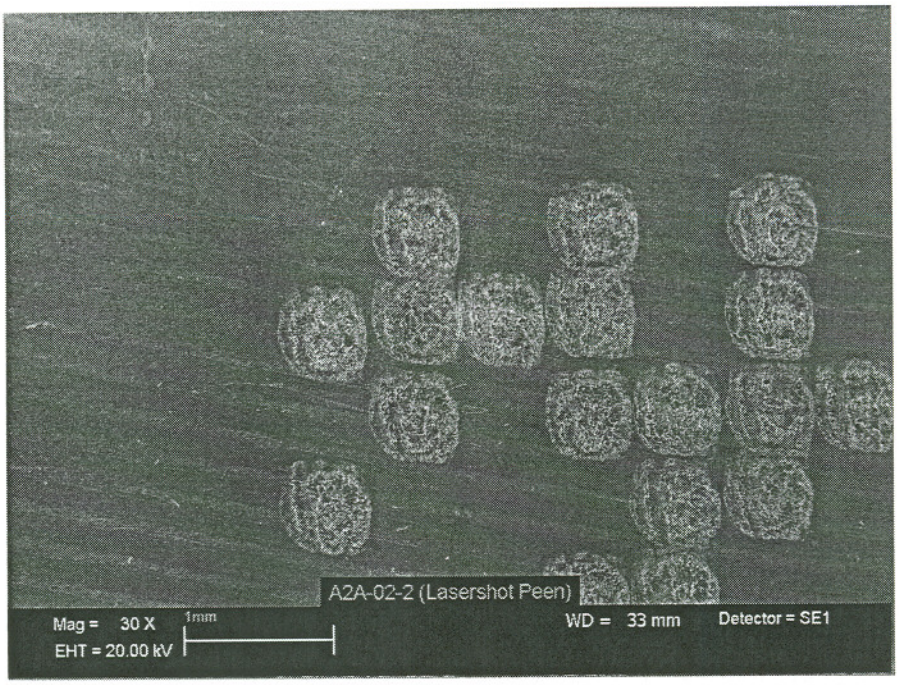


Figure A2A.2.1: SEM Surface Image of Lasershot™ Peen Cells (~30X)

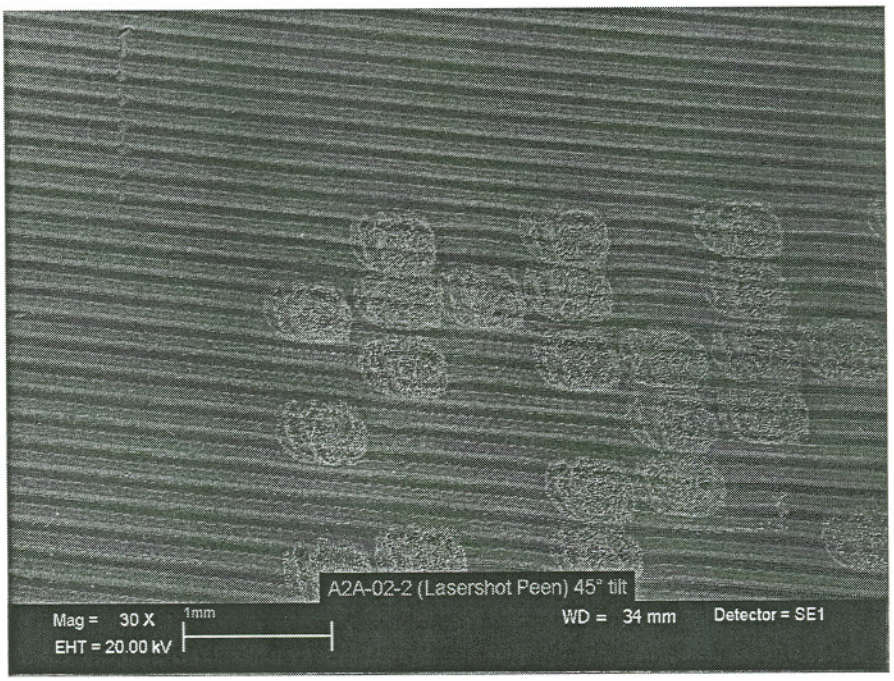


Figure A2A.2.2: SEM Surface Image of Lasershot™ Peen Cells at 45° Tilt (~30X)

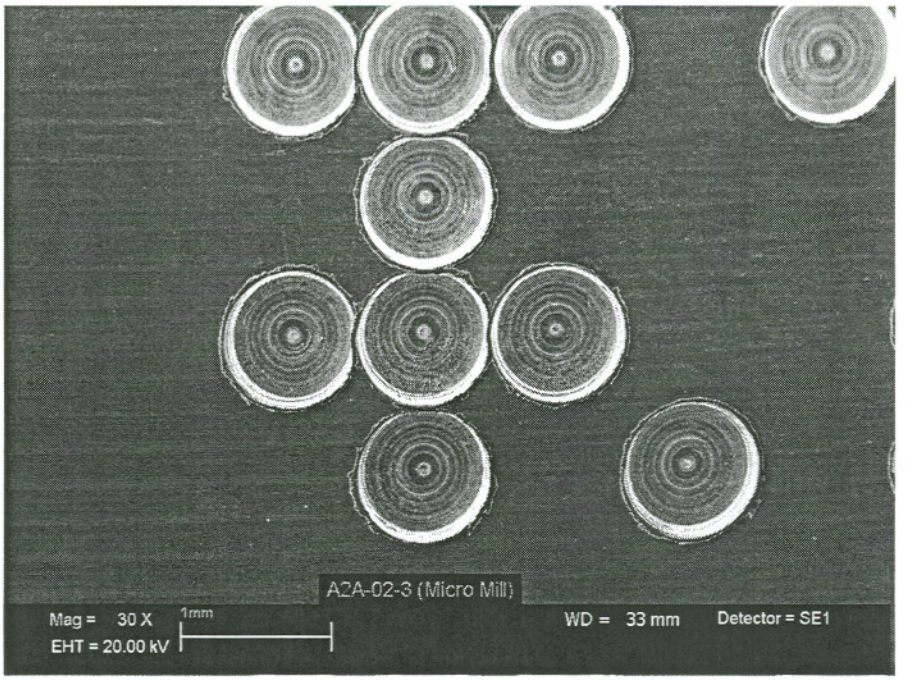


Figure A2A.3.1: SEM Surface Image of Micro-Mill Cells (~30X)

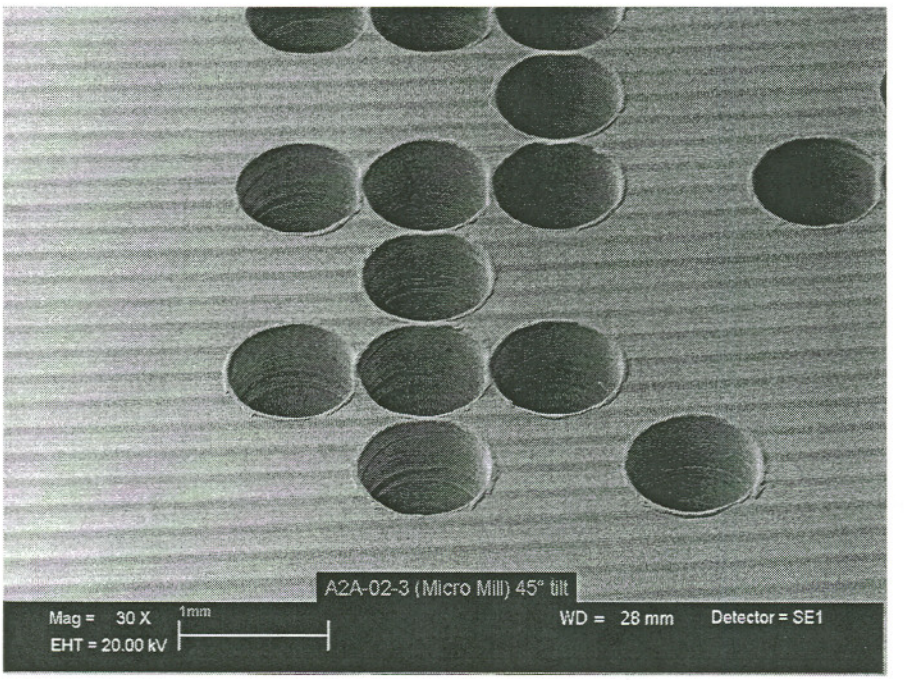


Figure A2A.3.2: SEM Surface Image of Micro-Mill Cells at 45° Tilt (~30X)

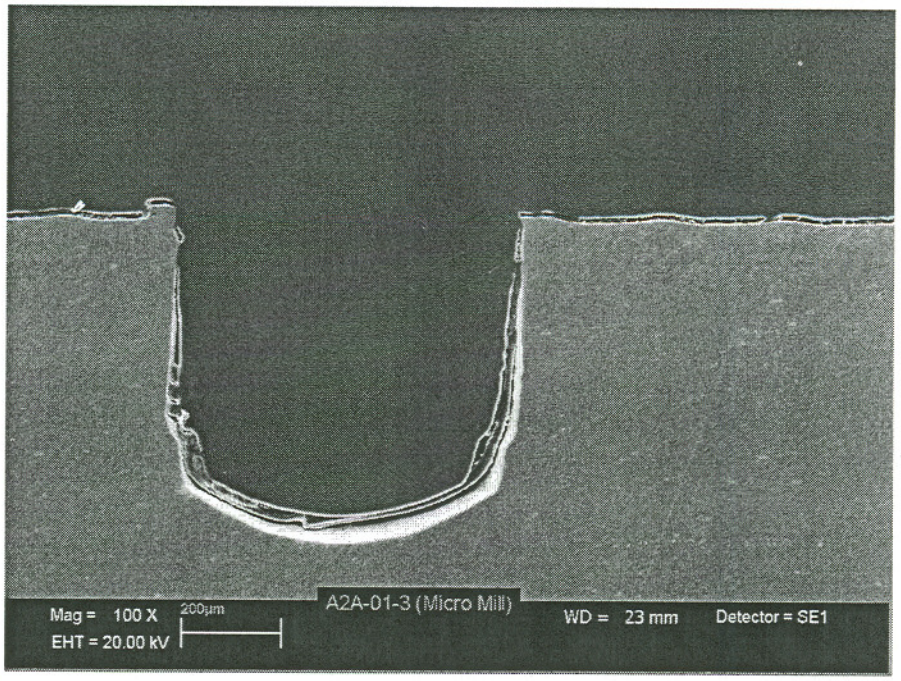


Figure A2A.3.3: SEM Cross Section Image of Micro-Mill Cells (~100X)

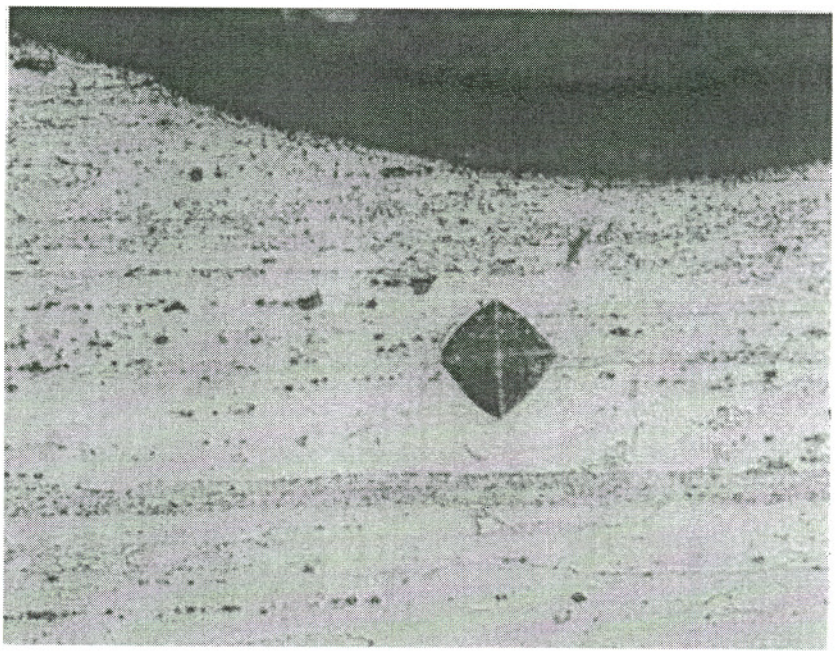


Figure A2A.3.4: Optical Cross Section Image of Etched Micro-Mill Cell (~500X)

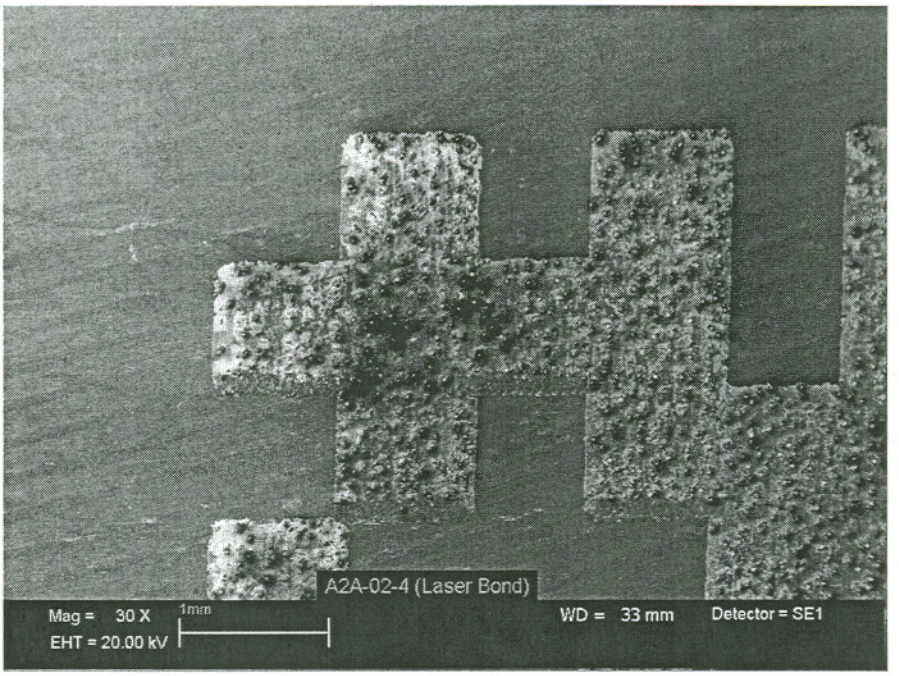


Figure A2A.4.1: SEM Surface Image of Laser Bond Cells (~30X)

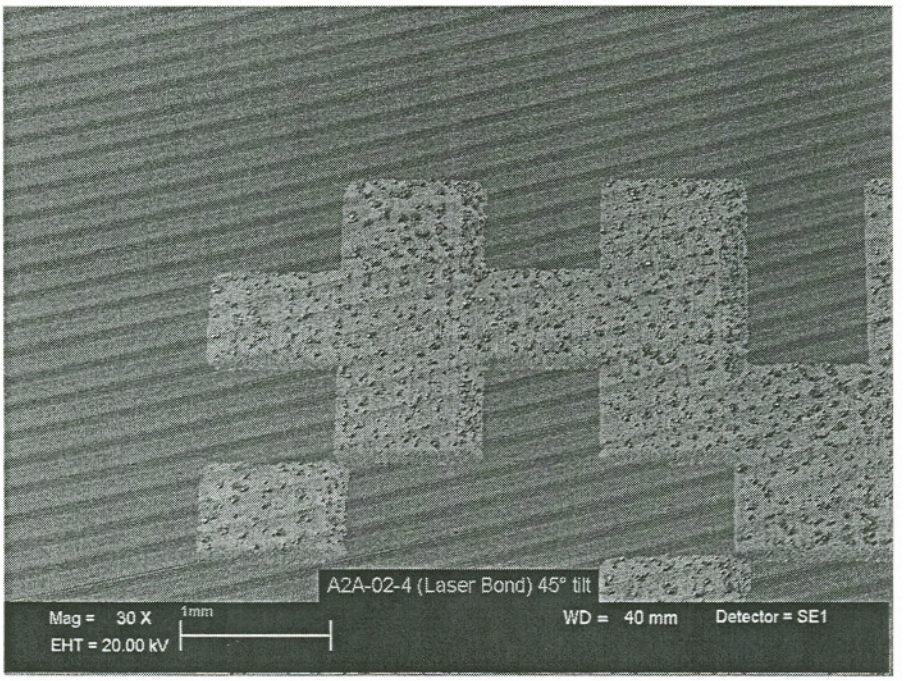


Figure A2A.4.2: SEM Surface Image of Laser Bond Cells at 45° Tilt (~30X)

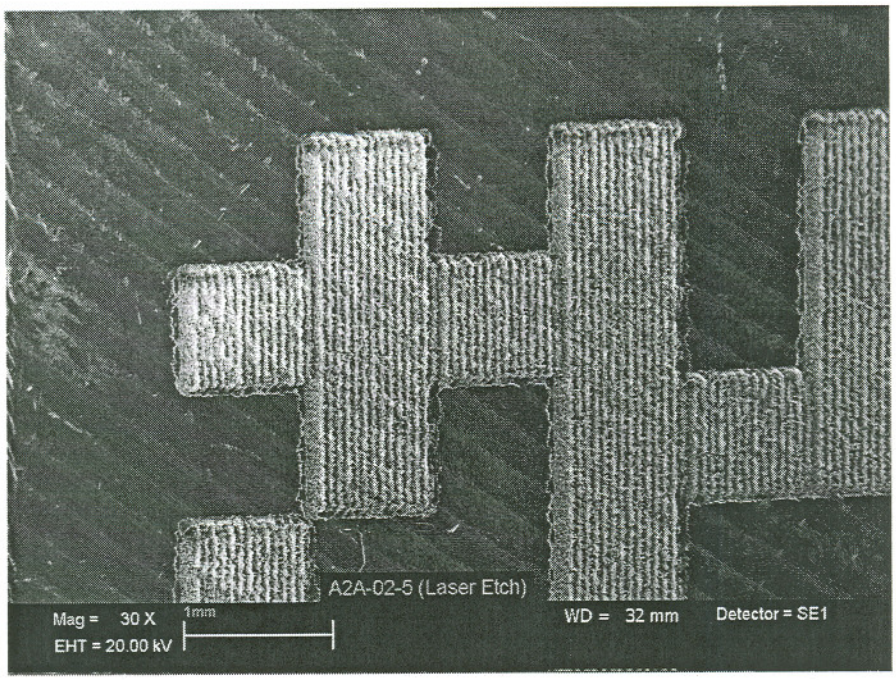


Figure A2A.5.1: SEM Surface Image of Laser Etch Cells (~30X)

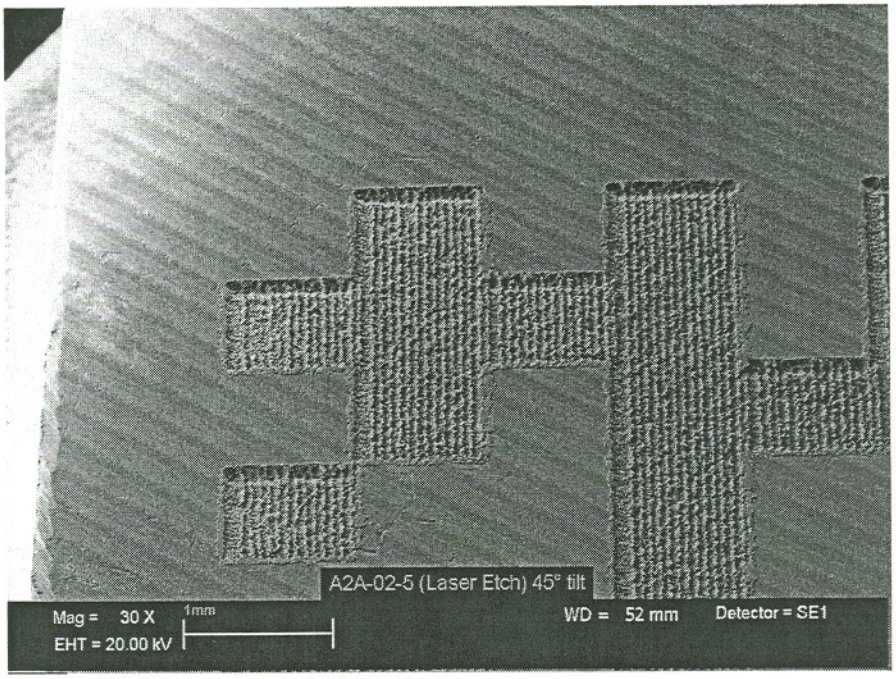


Figure A2A.5.2: SEM Surface Image of Laser Etch Cells at 45° Tilt (~30X)

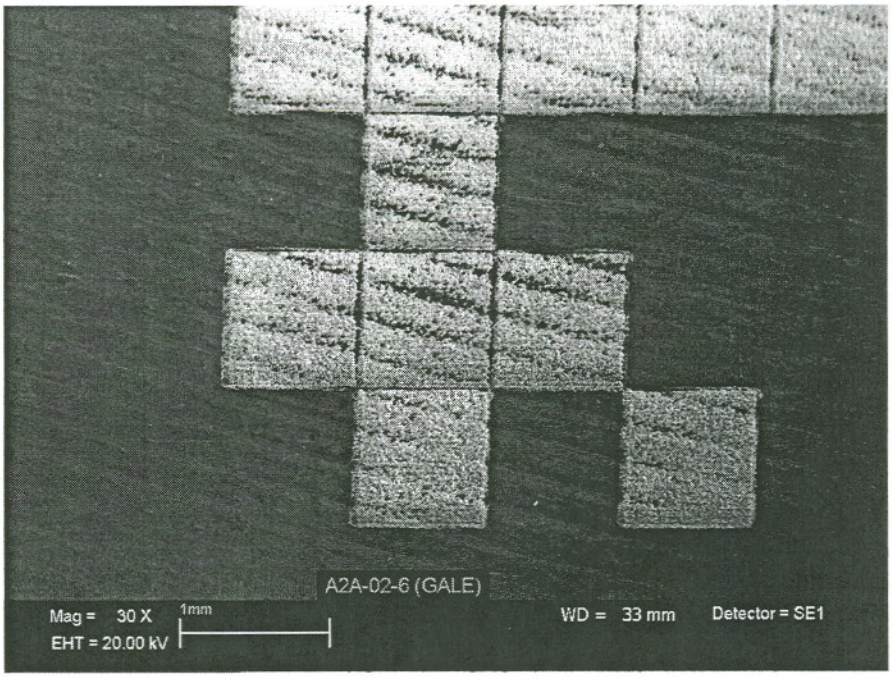


Figure A2A.6.1: SEM Surface Image of GALE Cells (~30X)

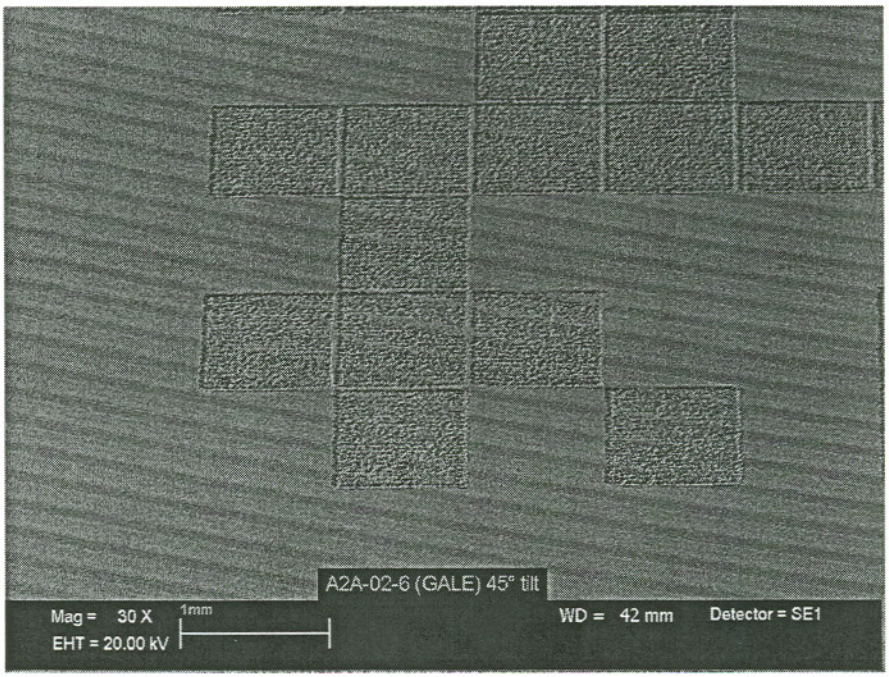


Figure A2A.6.2: SEM Surface Image of GALE Cells at 45° Tilt (~30X)

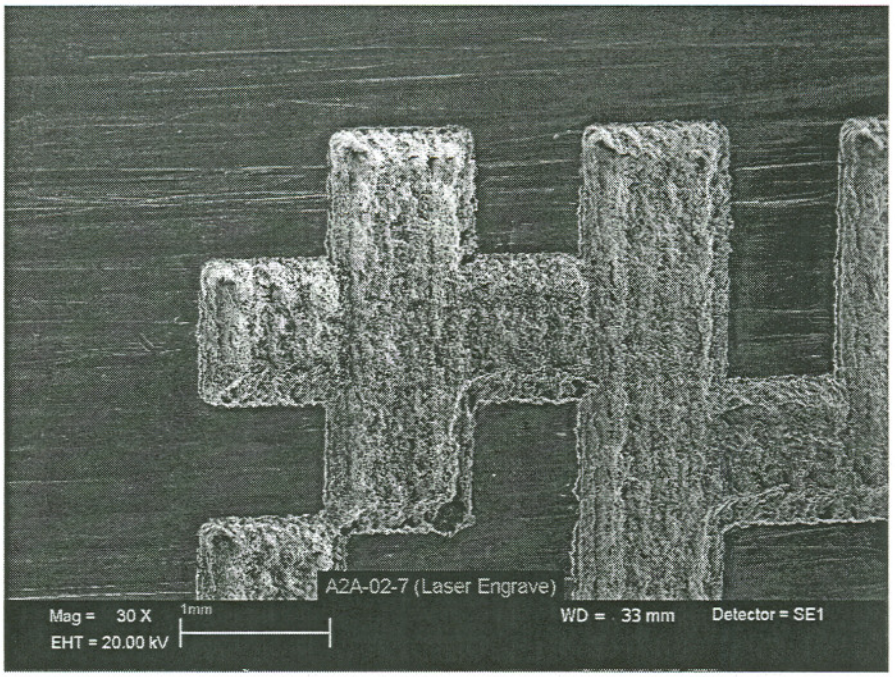


Figure A2A.7.1: SEM Surface Image of Laser Engrave Cells (~30X)

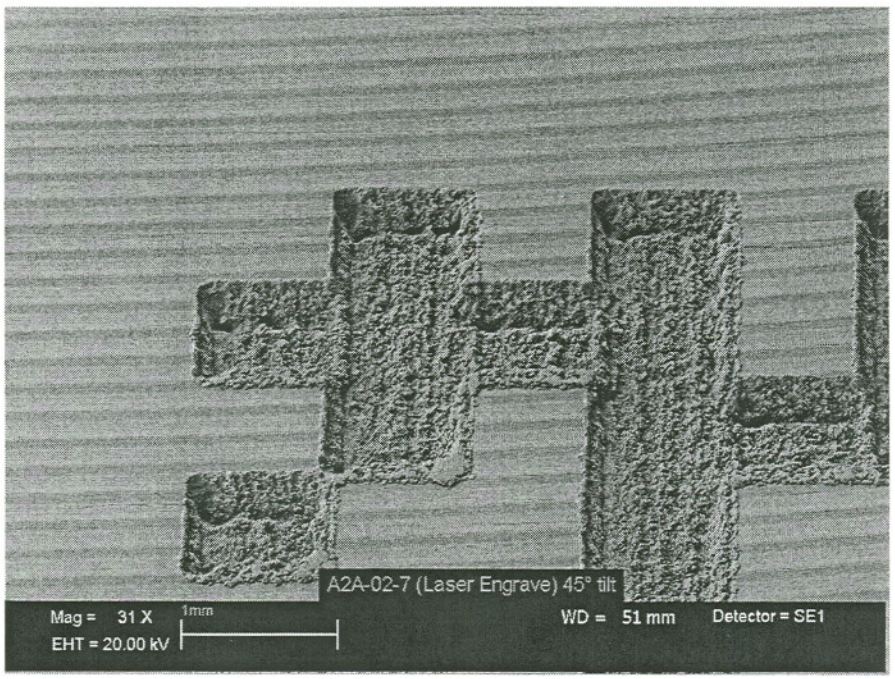


Figure A2A.7.2: SEM Surface Image of Laser Engrave Cells at 45° Tilt (~30X)

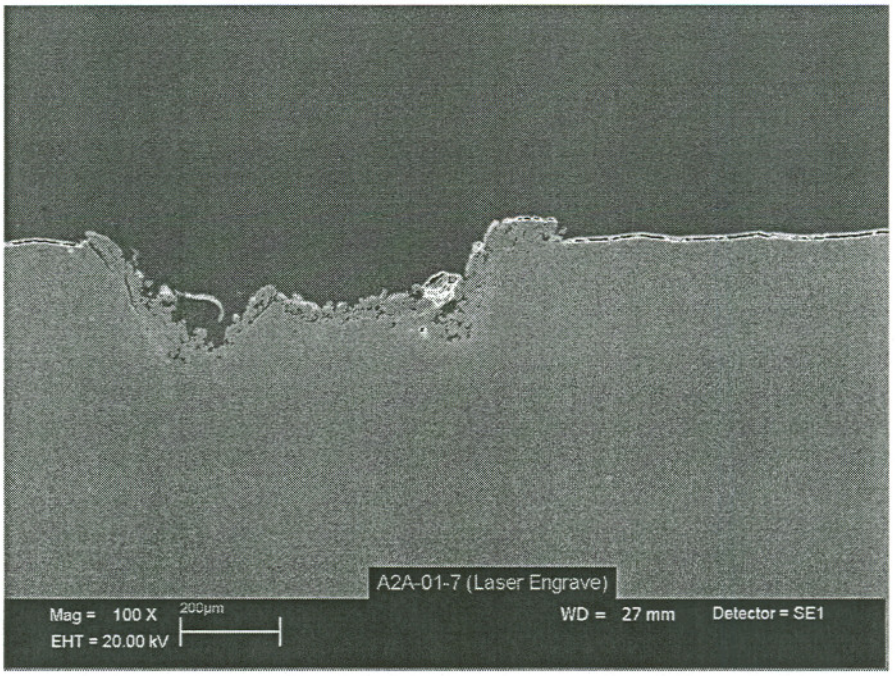


Figure A2A.7.3: SEM Cross Section Image of Laser Engrave Cells (~100X)

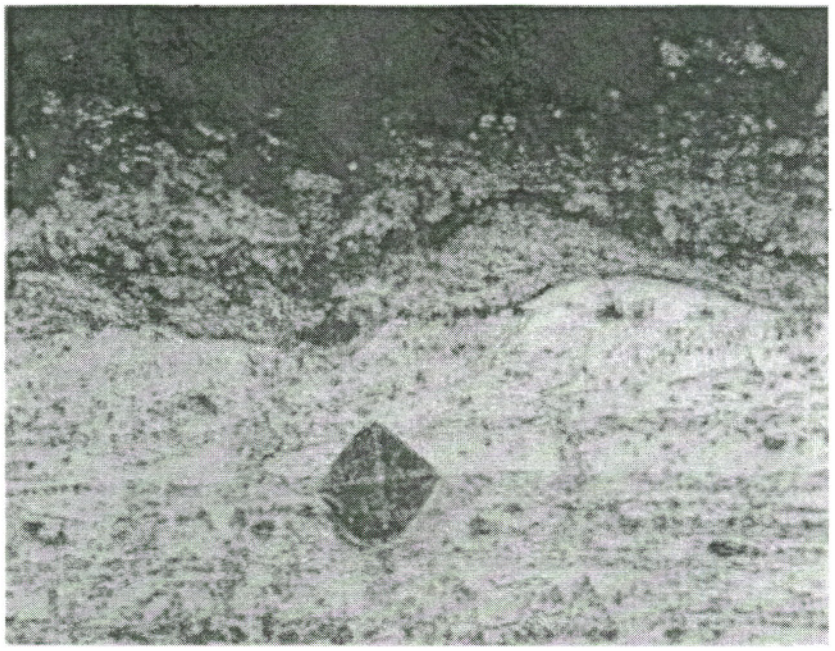


Figure A2A.7.4: Optical Cross Section Image of Etched Laser Engrave Cell (~500X)

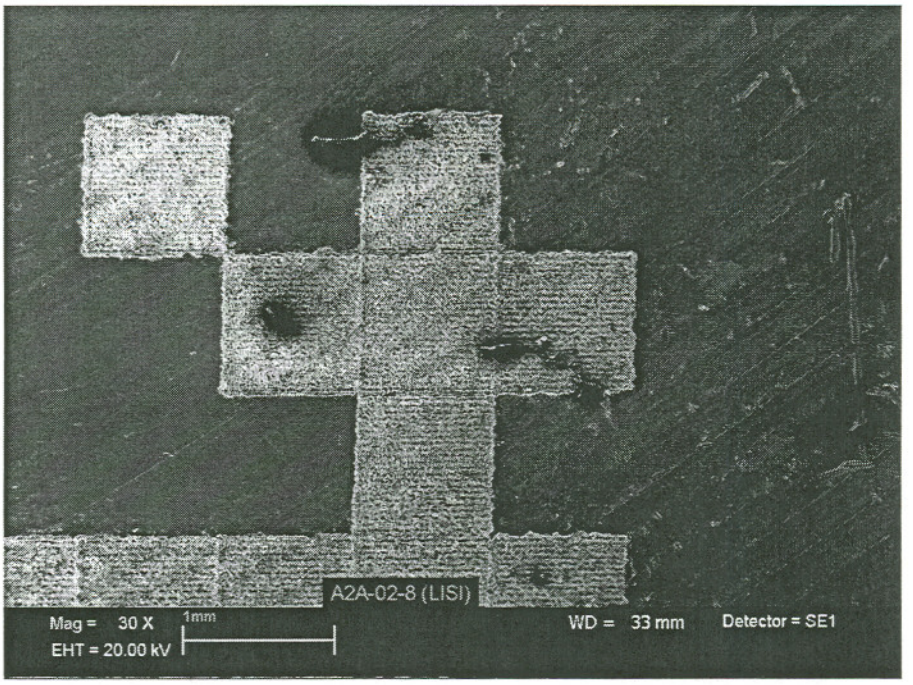


Figure A2A.8.1: SEM Surface Image of LISI Cells (~30X)

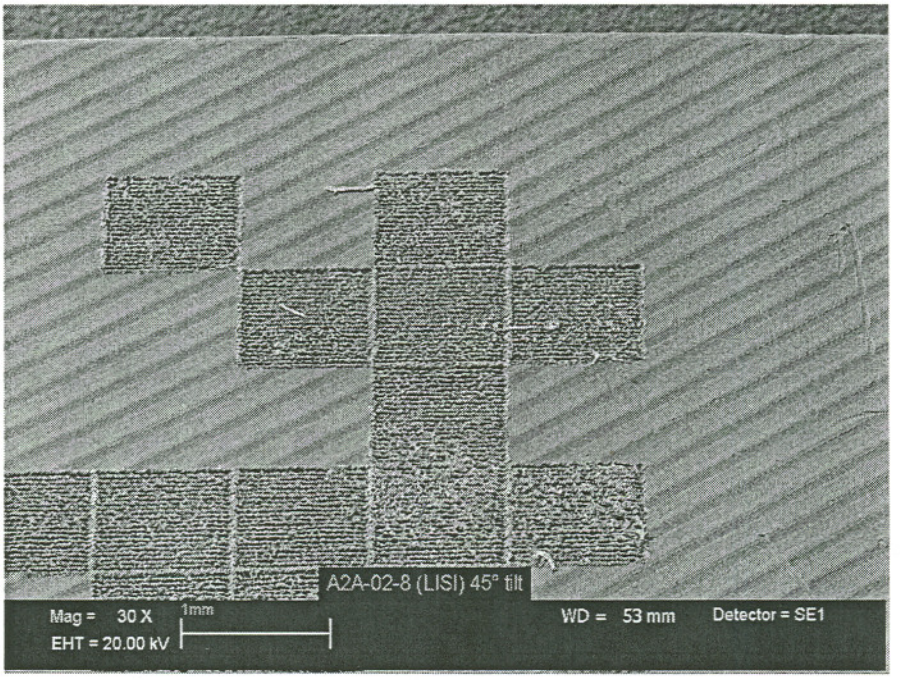


Figure A2A.8.2: SEM Surface Image of LISI Cells at 45° Tilt (~30X)

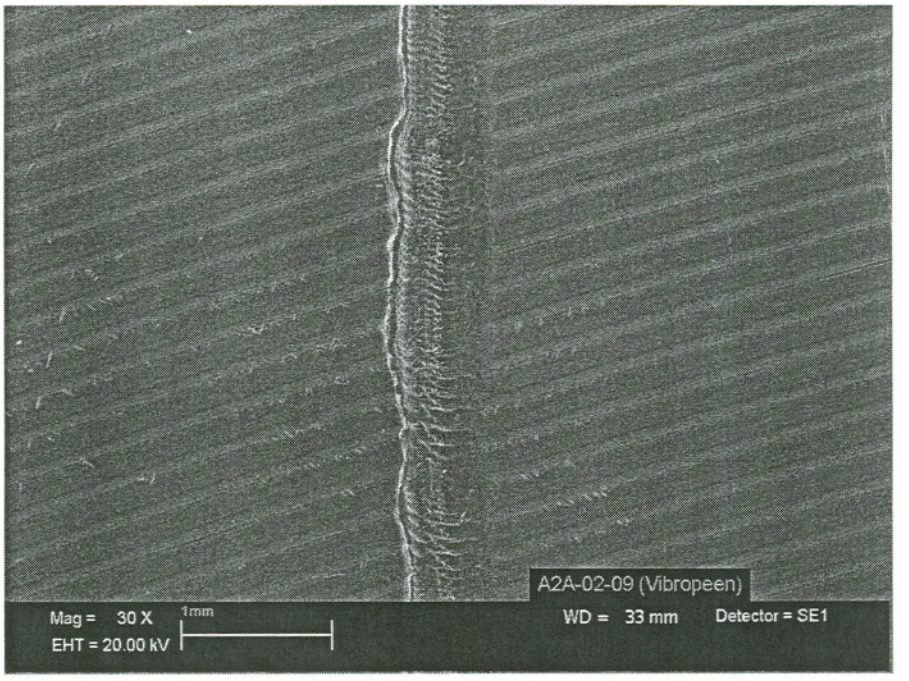


Figure A2A.9.1: SEM Surface Image of Vibropeen Mark (~30X)

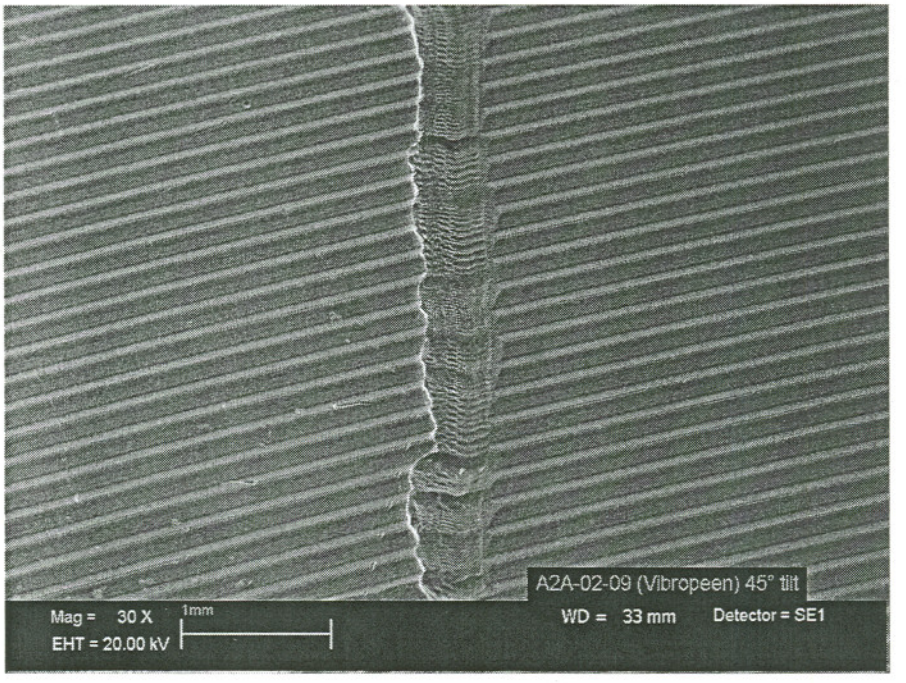


Figure A2A.9.2: SEM Surface Image of Vibropeen Mark at 45° Tilt (~30X)

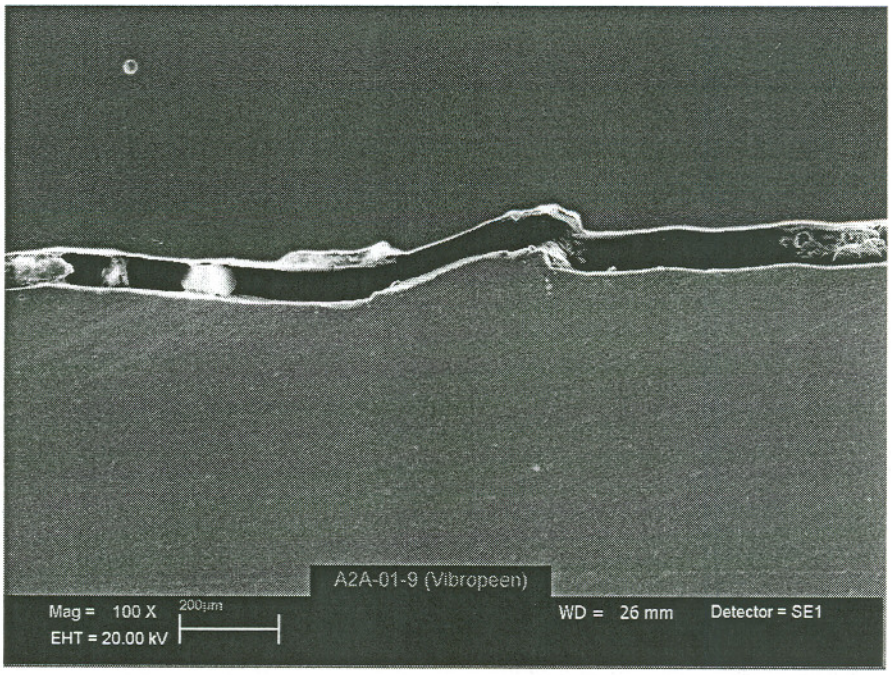


Figure A2A.9.3: SEM Cross Section Image of Vibropeen Mark (~100X)

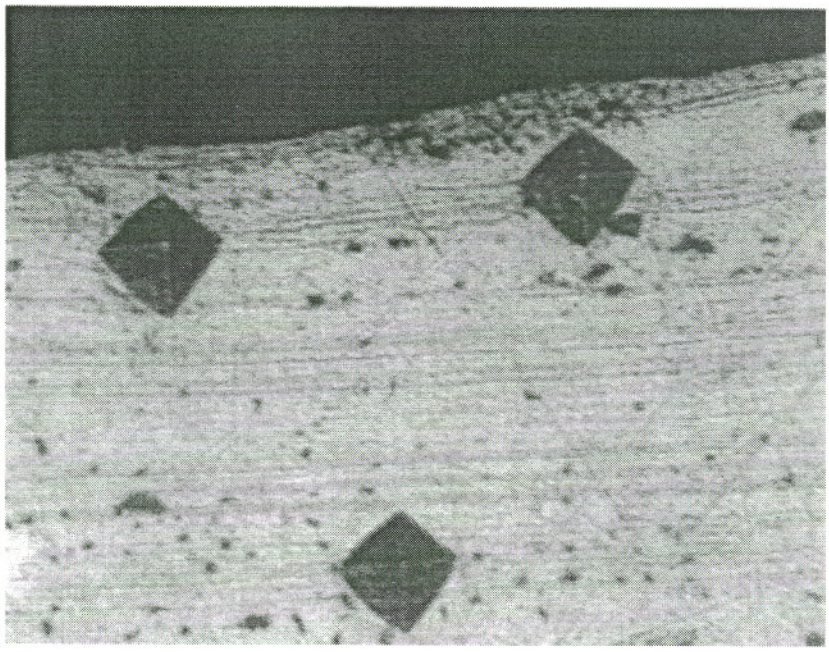


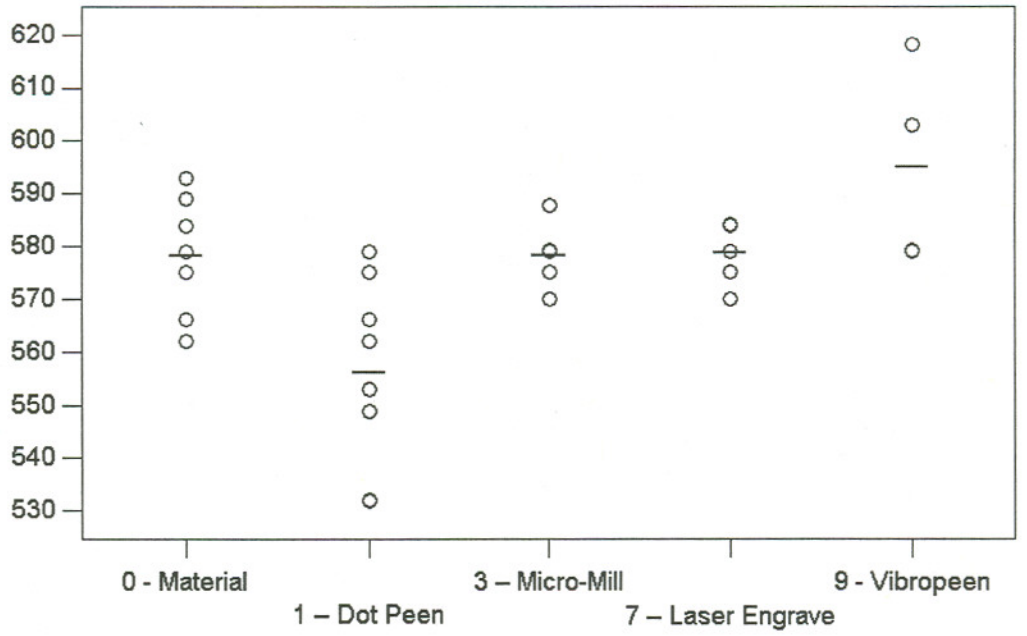
Figure A2A.9.4: Optical Cross Section Image of Etched Vibropeen Mark (~500X)

APPENDIX E
COUPON MARK MICROSCOPY DOCUMENTATION
MICROHARDNESS DATA
TYPICAL MICROHARDNESS INDENTATION IMAGES

Coupon S2A: Microhardness Data for 200g Applied Load with a 30s Dwell Time

Mark	Depth from Cell Surface (in)	Indent Diagonal (μm)	Diamond Pyramid Hardness DPH (kg/mm^2)
Material	Core	25.2	584
	Core	25.1	589
	Core	25.5	575
	Core	25.3	579
	Core	25.6	566
	Core	25.0	593
	Core	25.7	562
1 – Dot Peen	0.001	25.9	553
	0.001	26.4	532
	0.001	26.0	549
	0.001	26.4	532
	0.002	25.6	566
	0.003	25.7	562
	0.004	25.3	579
	0.005	25.4	575
3 – Micro-Mill	0.001	25.5	570
	0.001	25.3	579
	0.001	25.3	579
	0.003	25.3	579
	0.003	25.4	575
7 – Laser Engrave	0.001	25.3	579
	0.001	25.2	584
	0.001	25.5	570
	0.001	25.4	575
	0.001	25.4	575
	0.003	25.2	584
	0.003	25.2	584
	0.003	25.3	579
9 - Vibropeen	0.001	24.5	618
	0.001	24.8	603
	0.005	25.3	579
	0.005	25.3	579

Coupon S2A: Dot Plot of Microhardness Data



Coupon S2A: ANOVA of Microhardness Data

Analysis of Variance Coupon S2A

Source	DF	SS	MS	F	P
	4	4641	1160	7.15	0.000
Error	27	4383	162		
Total	31	9024			

Level	N	Mean	StDev
0 - Material	7	578.29	11.48
1 - Dot Peen	8	556.00	17.87
3 - Micro-Mill	5	576.40	3.97
7 - Laser Engrave	8	578.75	5.18
9 - Vibropeen	4	594.75	19.19

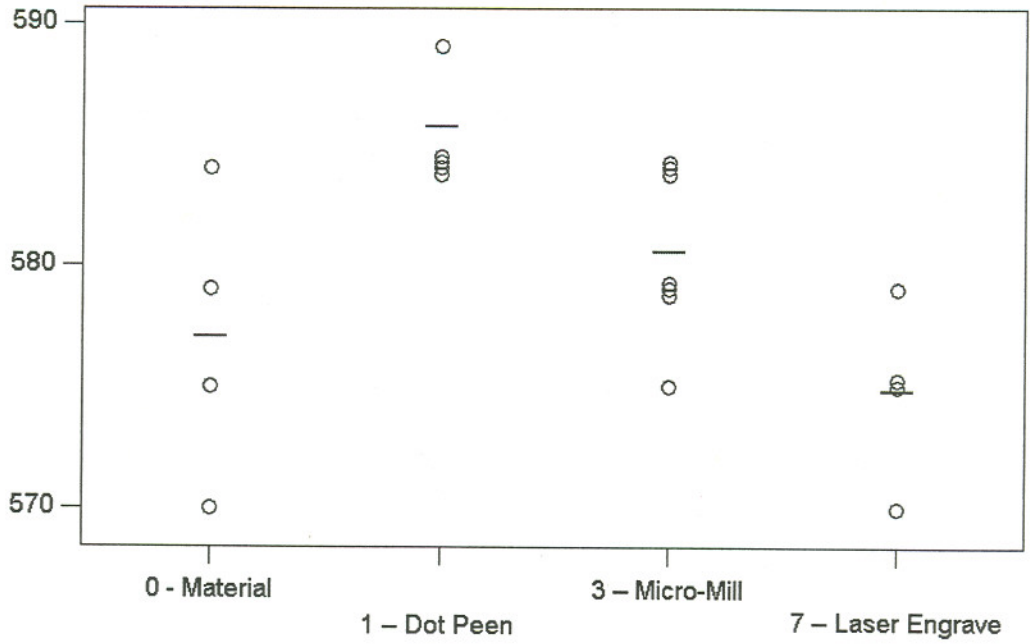
Pooled StDev = 12.74

```
                    Individual 95% CIs For Mean
                    Based on Pooled StDev
                    -------+---------+---------+---------
                               (----*----)
                    (----*----)
                             (-----*-----)
                                (---*----)
                                      (-----*------)
                    -------+---------+---------+---------
                       560.0     580.0     600.0
```

Coupon S2B: Microhardness Data for 200g Applied Load with a 30s Dwell Time

Mark	Depth from Cell Surface (in)	Indent Diagonal (μm)	Diamond Pyramid Hardness DPH (kg/mm^2)
Material	Core	25.3	579
	Core	25.2	584
	Core	25.4	575
	Core	25.5	570
1 - Dot Peen	0.001	25.1	589
	0.001	25.2	584
	0.002	25.2	584
	0.002	25.2	584
	0.005	25.2	584
	0.005	25.1	589
3 – Micro-Mill	0.001	25.3	579
	0.001	25.4	575
	0.001	25.3	579
	0.001	25.3	579
	0.002	25.2	584
	0.002	25.2	584
	0.002	25.2	584
7 – Laser Engrave	0.001	25.4	575
	0.001	25.5	570
	0.003	25.4	575
	0.003	25.3	579

Coupon S2B: Dot Plot of Microhardness Data



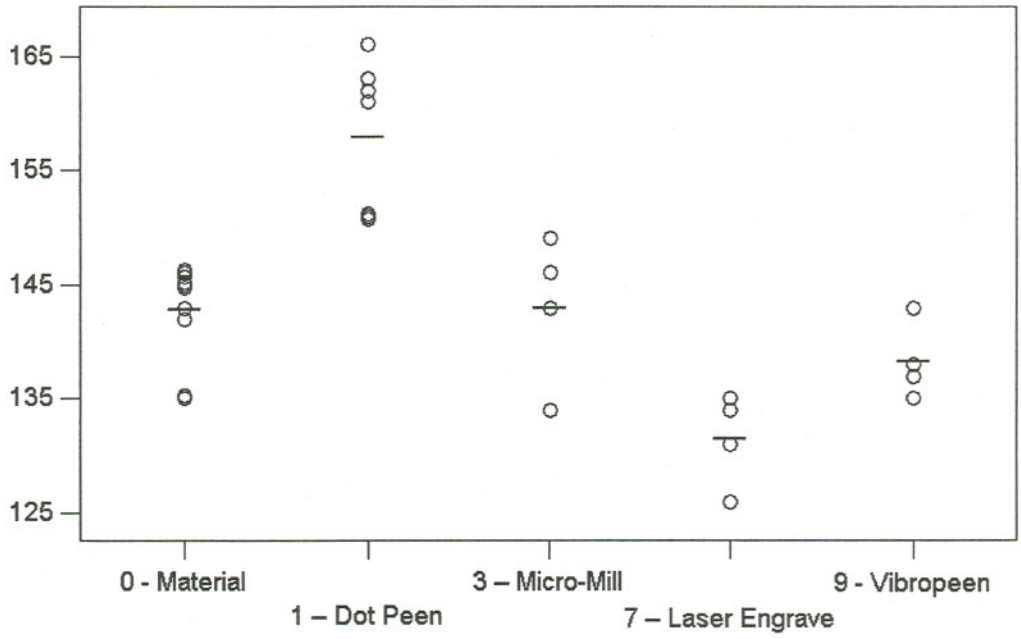
Coupon S2B: ANOVA of Microhardness Data

```
Analysis of Variance for Coupon S2B
Source      DF        SS        MS        F        P
             3     340.0     113.3     7.59    0.002
Error       17     253.8      14.9
Total       20     593.8
                                          Individual 95% CIs For Mean
                                          Based on Pooled StDev
Level        N            Mean     StDev  ---------+---------+---------+-------
0 - Material      4    577.00      5.94       (-------*-------)
1 - Dot Peen      6    585.67      2.58                          (-----*------)
3 - Micro-Mill    7    580.57      3.51                 (-----*-----)
7 - Laser Engrave 4    574.75      3.69  (--------*-------)
                                          ---------+---------+---------+-------
Pooled StDev =      3.86                       575.0     580.0     585.0
```

Coupon A2A: Microhardness Data for 100g Applied Load with a 30s Dwell Time

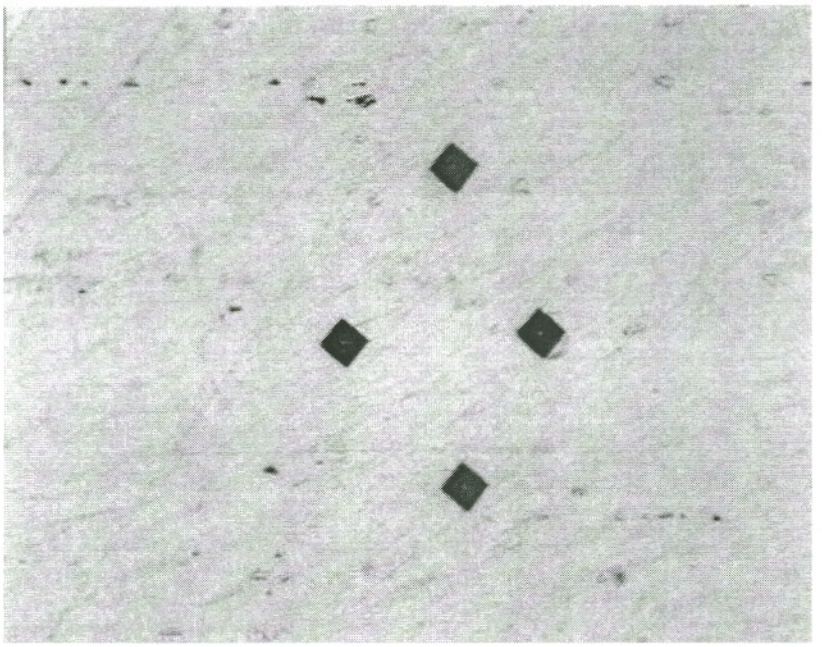
Mark	Depth from Cell Surface (in)	Indent Diagonal (μm)	Diamond Pyramid Hardness DPH (kg/mm^2)
Material	Core	35.6	146
	Core	35.7	145
	Core	35.7	145
	Core	35.6	146
	Core	37.0	135
	Core	37.1	135
	Core	35.6	146
	Core	35.7	145
	Core	36.1	142
	Core	36.0	143
1 - Dot Peen	0.002	33.9	161
	0.002	33.7	163
	0.002	33.8	162
	0.002	33.4	166
	0.003	35.1	151
	0.003	35.0	151
	0.004	35.0	151
3 – Micro-Mill	0.002	35.3	149
	0.002	35.7	146
	0.004	37.2	134
	0.004	36.0	143
7 – Laser Engrave	0.002	38.4	126
	0.002	37.6	131
	0.004	37.0	135
	0.004	37.2	134
9 - Vibropeen	0.001	36.8	137
	0.001	37.0	135
	0.005	36.0	143
	0.005	36.7	138

Coupon A2A: Dot Plot of Microhardness Data

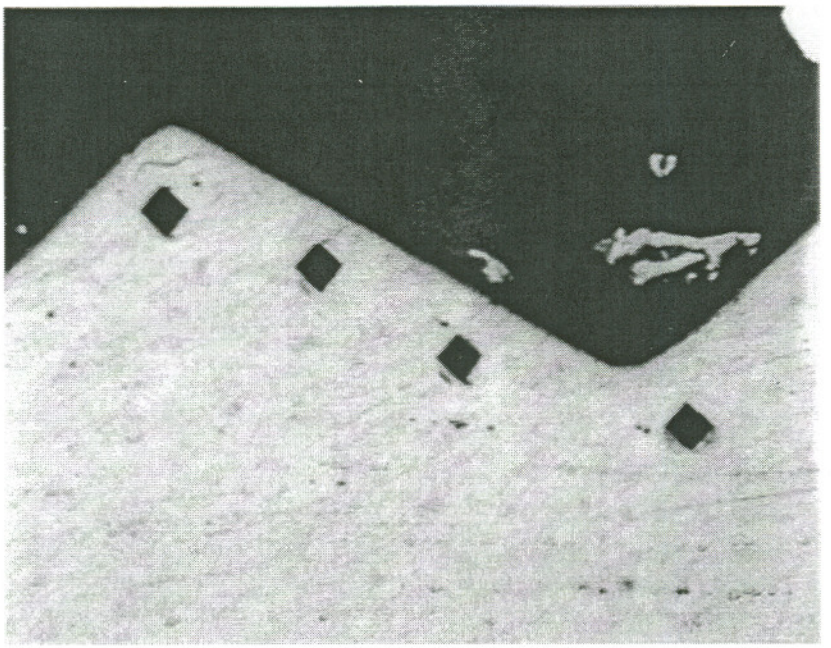


Coupon A2A: ANOVA of Microhardness Data

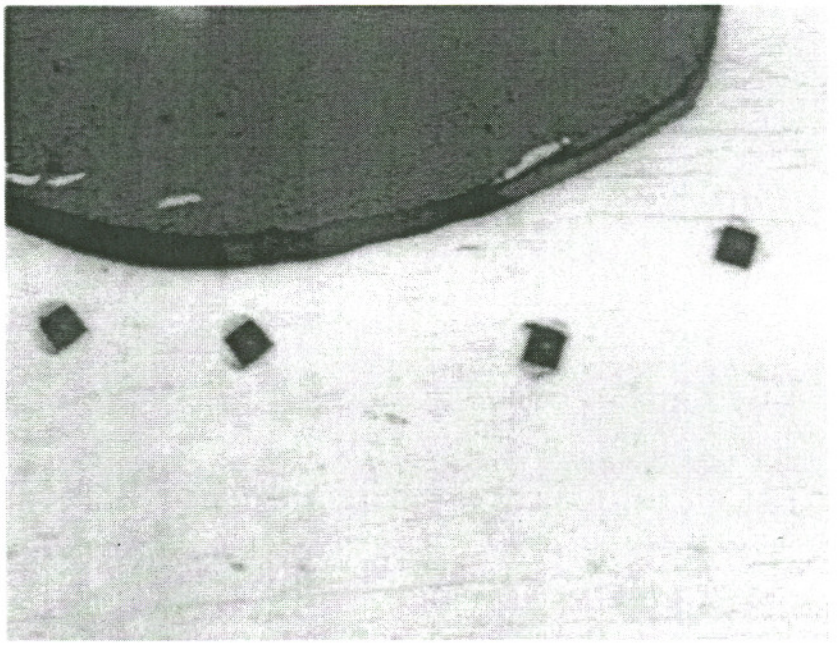
```
Analysis of Variance for Coupon A2A
Source      DF        SS        MS        F        P
             4    2117.6     529.4    19.91    0.000
Error       24     638.2      26.6
Total       28    2755.8
                                        Individual 95% CIs For Mean
                                        Based on Pooled StDev
Level              N      Mean     StDev ----+---------+---------+---------+--
0 - Material      10    142.80      4.32              (---*--)
1 - Dot Peen       7    157.86      6.59                            (---*---)
3 - Micro-Mill     4    143.00      6.48            (----*----)
7 - Laser Engrave  4    131.50      4.04  (-----*----)
9 - Vibropeen      4    138.25      3.40        (----*-----)
                                        ----+---------+---------+---------+--
Pooled StDev =      5.16                130.0     140.0     150.0     160.0
```



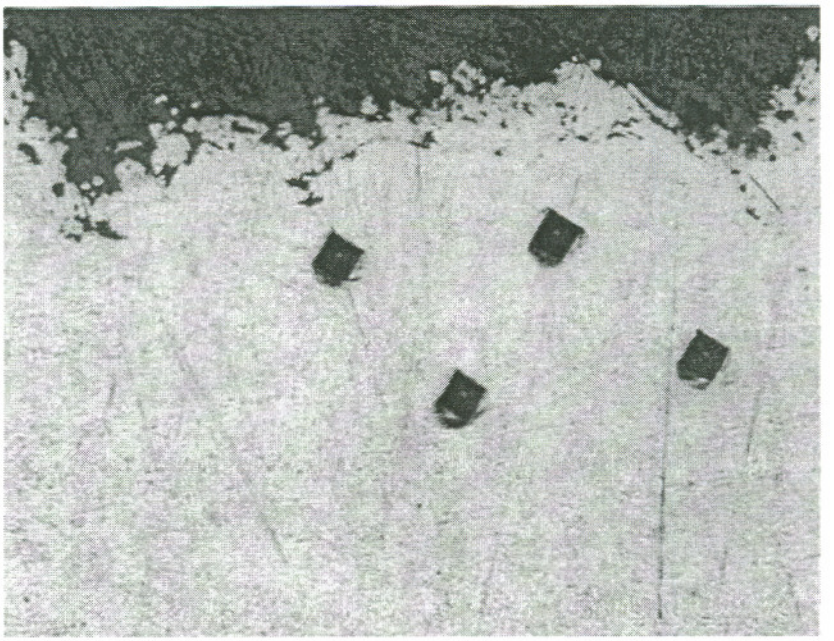
Coupon A2A: H.0: Optical Cross Section Image with Microhardness Indentations: Material (~200X)



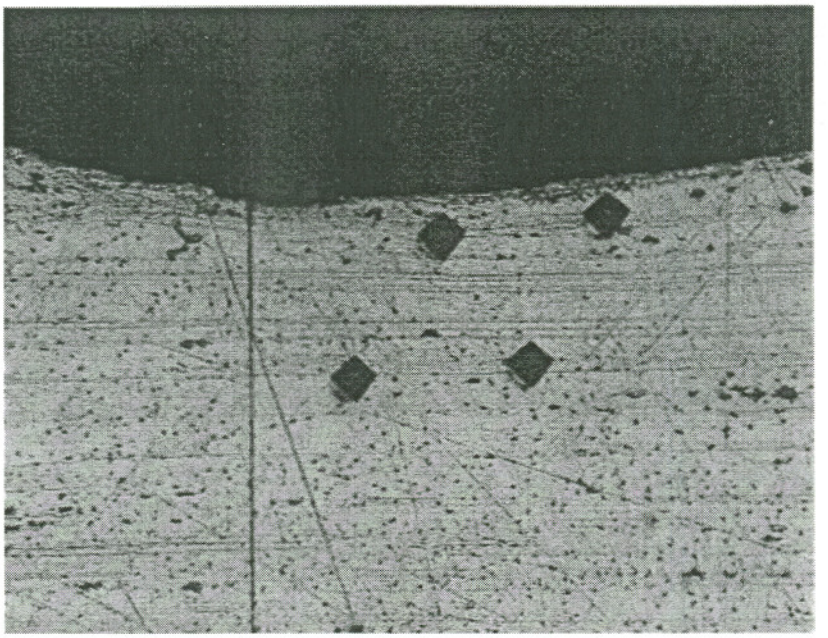
Coupon A2A: H.1: Optical Cross Section Image with Microhardness Indentations: Dot Peen (~200X)



Coupon A2A: H.3: Optical Cross Section Image with Microhardness Indentations: Micro-Mill (~200X)



Coupon A2A: H.7: Optical Cross Section Image with Microhardness Indentations: Laser Engrave (~200X)



Coupon A2A: H.9: Optical Cross Section Image with Microhardness Indentations: Vibropeen (~200X)