Appendix E - E-beam Vapor Distribution

During a visit to 3M Corporation's Metal Matrix Composites Program Division (Eden Prairie, MN), thickness profile measurements were taken of a high-vacuum e-beam source's Ti-6(wt%)Al-4(wt%)V vapor density distribution. Evaporant was produced in a high vacuum chamber (pressure $\sim 1x10^{-5}$ Torr) by a 90° 25 kW/25 kV e-gun (Leybold-Heraeus). The deposits were made on a plate parallel to the evaporant surface and 33 cm above it. The 4.92 cm diameter vapor source, contained in a water-cooled crucible, was scanned by a 0.635 mm diameter beam to a radius of 1.90 cm. Table E.1 shows deposit thickness data taken from the substrate. Fig. E.1 and E.2 show the deposit thickness profile across the plate. Note that the deposit is not completely symmetric about the point taken to be directly above the center of the evaporant (data point 33).

Given the deposit's lack of symmetry and the narrow width of the plate, only data points with y = 5.1 cm were used to determine the dependence of deposit thickness upon position. To find the exponent of equation (2.2) Schiller [11] gives an equation (equation (2.3)) for relative film thickness d_s/d_{so} on a plane parallel to a vapor emitting source as a function of r_s/h_v and the exponent n. Analysis of data points with $x \leq 14.0$ cm revealed that their interpolation function most closely fit a distribution with n = 4.5. Similar anaylsis of data points with $x \geq 14.0$ cm revealed a close fit to the distribution with n = 5.0.

Table E.1: Deposited vapor thickness versus location

point	x (m)	y (m)	thickness (m)	point	x (m)	y (m)	thickness (m)
1	0.000	0.000	0.0051	31	0.140	0.000	0.0091
2	0.000	0.023	0.0051	32	0.140	0.023	0.0099
3	0.000	0.051	0.0056	33	0.140	0.051	0.0109
4	0.000	0.074	0.0051	34	0.140	0.074	0.0100
5	0.000	0.099	0.0048	35	0.140	0.099	0.0094
6	0.013	0.000	0.0056	36	0.165	0.000	0.0089
7	0.013	0.023	0.0056	37	0.165	0.023	0.0096
8	0.013	0.051	0.0061	38	0.165	0.051	0.0110
9	0.013	0.074	0.0058	39	0.165	0.074	0.0100
10	0.013	0.099	0.0053	40	0.165	0.099	0.0094
11	0.038	0.000	0.0066	41	0.190	0.000	0.0084
12	0.038	0.023	0.0071	42	0.190	0.023	0.0091
13	0.038	0.051	0.0076	43	0.190	0.051	0.0096
14	0.038	0.074	0.0071	44	0.190	0.074	0.0096
15	0.038	0.099	0.0076	45	0.190	0.099	0.0091
16	0.064	0.000	0.0076	46	0.216	0.000	0.0074
17	0.064	0.023	0.0081	47	0.216	0.023	0.0084
18	0.064	0.051	0.0086	48	0.216	0.051	0.0089
19	0.064	0.074	0.0081	49	0.216	0.074	0.0084
20	0.064	0.099	0.0076	50	0.216	0.099	0.0079
21	0.089	0.000	0.0084	51	0.241	0.000	0.0064
22	0.089	0.023	0.0091	52	0.241	0.023	0.0071
23	0.089	0.051	0.0099	53	0.241	0.051	0.0079
24	0.089	0.074	0.0091	54	0.241	0.074	0.0074
25	0.089	0.099	0.0084	55	0.241	0.099	0.0068
26	0.114	0.000	0.0096	56	0.267	0.000	0.0056
27	0.114	0.023	0.0098	57	0.267	0.023	0.0061
28	0.114	0.051	0.0110	58	0.267	0.051	0.0064
29	0.114	0.074	0.0100	59	0.267	0.074	0.0061
30	0.114	0.099	0.0091	60	0.267	0.099	0.0056

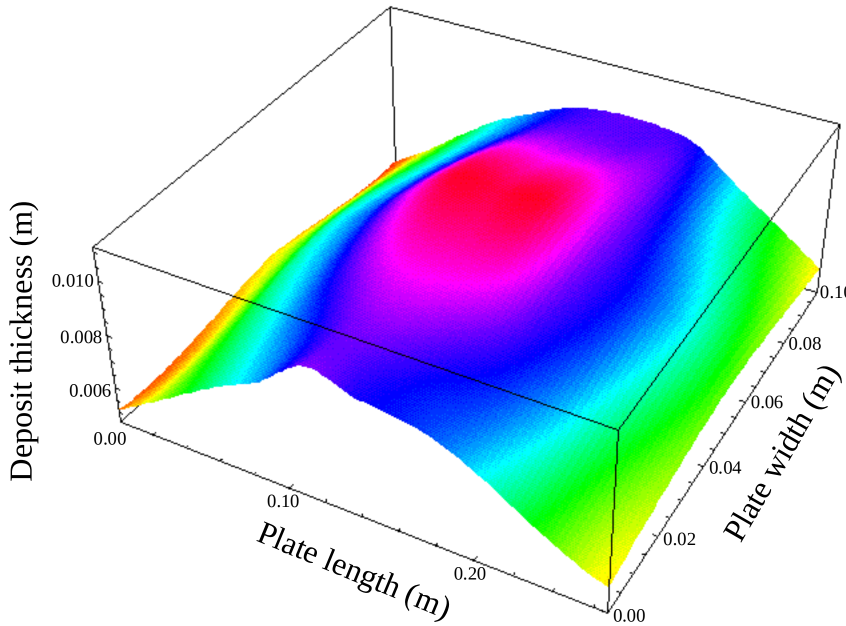

Figure E.1 **Distribution of Ti-6-4 on substrate located directly above evaporant.**

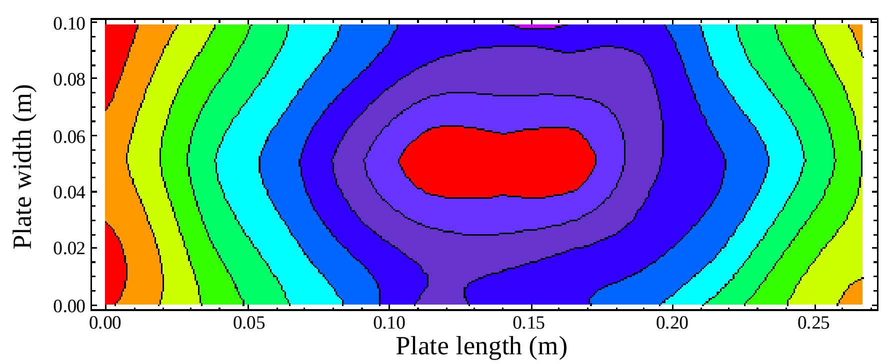

Figure E.2 **Ti-6-4 distribution on substrate directly above evaporant.**