



LAMINATION TOOLING

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THERMAL COEFFICIENT EXPANSION

According to a study done by Chris James, Ph.D., M.Sc. of Burroughs, Carlsbad, CA, multilayer laminates from five major vendors had the following expansion factors (...x 10⁻⁶ / ° C).

Vendor	Unclad		Clad	
	Warp	Weft	Warp	Weft
A	8.40	13.29	9.10	16.90
B	8.92	10.84	11.36	16.82
C	10.11	13.26	11.55	14.30
D	8.39	11.94	13.87	16.26
E	7.03	10.32	14.58	16.19
	8.66	11.93	12.10	16.10

12.20 average

SOURCE: *Physical Cause of Warp and Misregistration During Multilayer Lamination*, Chris James, Ph.D., M.Sc. of Burroughs, Carlsbad, CA.

Various types of multilayer tooling have the following TCE:

- Aluminum:** 22.4 x 10⁻⁶ / ° C
- Copper:** 16.2 x 10⁻⁶ / ° C
- AISI 304:** 17.6 x 10⁻⁶ / ° C
- AISI 420:** 11.0 x 10⁻⁶ / ° C
- AISI 630:** 11.6 x 10⁻⁶ / ° C
- AISI 4140H:** 12.7 x 10⁻⁶ / ° C

It is obvious that aluminum having a TCE of approximately twice the amount of the average laminate might cause problems.

A combination of AISI 4140H lamination plates and AISI 420 or 630 separator plates seems to offer the best package where lamination plates, separator plates and multilayer laminates contract and expand at the same rate.