ADVANCED CERAMICS MANUFACTURING

ClaveCore™

ClaveCore technology allows for specialized composite geometries to be formed Out Of AutoClave (OOA). When heated, a ClaveCore mandrel exhibits self-pressurizing behavior when confined inside a tool. The ClaveCore pressure can be used to produce an aerospace grade laminate. After the composite cure cycle, it can be removed with tap water.

ClaveCore key properties:

- Expands and self-pressurizes when heated
- Temperature-Pressure (onset-magnitude) is programmable by ACM
- Pressures up to 400 psi are possible depending on grade
- Water soluble
- Allows for complex, seamless (unbounded) structures
- Produces precision OML dimensions
- Produces high surface quality

Figure 1. ClaveCore mandrel and composite violin fabricated from 350°F prepreg.

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Table 1. Typical properties and attributes of ACM tooling systems.

Tooling System	Complexity	Tolerances [in]	**Peak Pressure [psi]	Composite Processing Window [°F]	Density [g/cm^3]	Compressive Strength [psi]	CTE [ppm/°C]
ClaveCore LT	High	Female tool limited		250 to ~350	0.6-0.8	490 ± 120	NA
*ClaveCore HT	High	Female tool limited		480 to ~750	TBD	TBD	NA

*Under development **Variable depending on grade, geometry, and process conditions

Table 2. ClaveCore LT grades and expansion behavior.

			Peak Pressure [psi]						
			[0% Expansion]		[5% Expansion]		[30% Expansion]		
Commercial Grade	Max T [°C]	Max T [°F]	120°C	180°C	120°C	180°C	120°C	180°C	*Pressurization Model
LT-A	138	280	90	130	90	140	60	80	P(T,V%) = (-0.012*T+0.315) *V% +0.616*T+16.65
LT-B	138	280	160	230	160	230	80	110	P(T,V%) = (-0.027*T+0.959) *V% +1.186*T+20.05
LT-C	138	280	210	280	200	280	120	150	P(T,%V) = (-0.018*T-0.697) *V% +1.079*T+88.5
LT-D	138	280	230	270	220	270	140	200	P(T,V%) = (0.011*T-4.767) *V% +0.750*T+140.3
LT-E	138	280	250	370	240	340	170	220	P(T,V%) = (-0.027*T-0.058) *V% +1.504*T+76.21
LT-F	138	280	90	130	80	120	45	90	P(T,V%) = (0.005*T-2.104) *V% +0.623*T+15.61
LT-G	138	280	100	160	90	130	50	80	P(T,V%) = (-0.009*T-0.625) *V% +0.790*T+0.728
LT-H	138	280	140	180	110	160	80	100	P(T,V%) = (-0.009*T-0.835) *V% +0.821*T+26.94
LT-J	138	280	150	190	140	190	80	110	P(T,V%) = (-0.006*T-1.970) *V% +0.795*T+51.95
LT-K	138	280	100	230	90	200	70	130	P(T,V%) = (-0.032*T+2.613) *V% +1.645*T-92.90
LT-L	204	400	90	190	100	150	20	90	P(T,V%) = (-0.005*T-2.249) *V% +1.471*T-80.52

*Pressurization Model Notes: T=°C, V%=Volume Expansion (Enter 50% expansion as “50.0”)

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