



ENGINEERED  
SYNTACTIC  
SYSTEMS

# ESS-TOOL<sup>®</sup> Composite Syntactic Tool Board

Performance Engineered to Fit  
Today's Production Demands



## ESS-TOOL<sup>®</sup> Direct-Cut Production-Ready Tool Board



Tough. Durable. Low CTE – *from room temperature to full use temperature.*

ESS-TOOL delivers all the expected quality properties *plus* enhancements to reduce machining time by 50% or more, cure cycle time by 50% or more and can eliminate the need to produce a master for small quantity production runs.

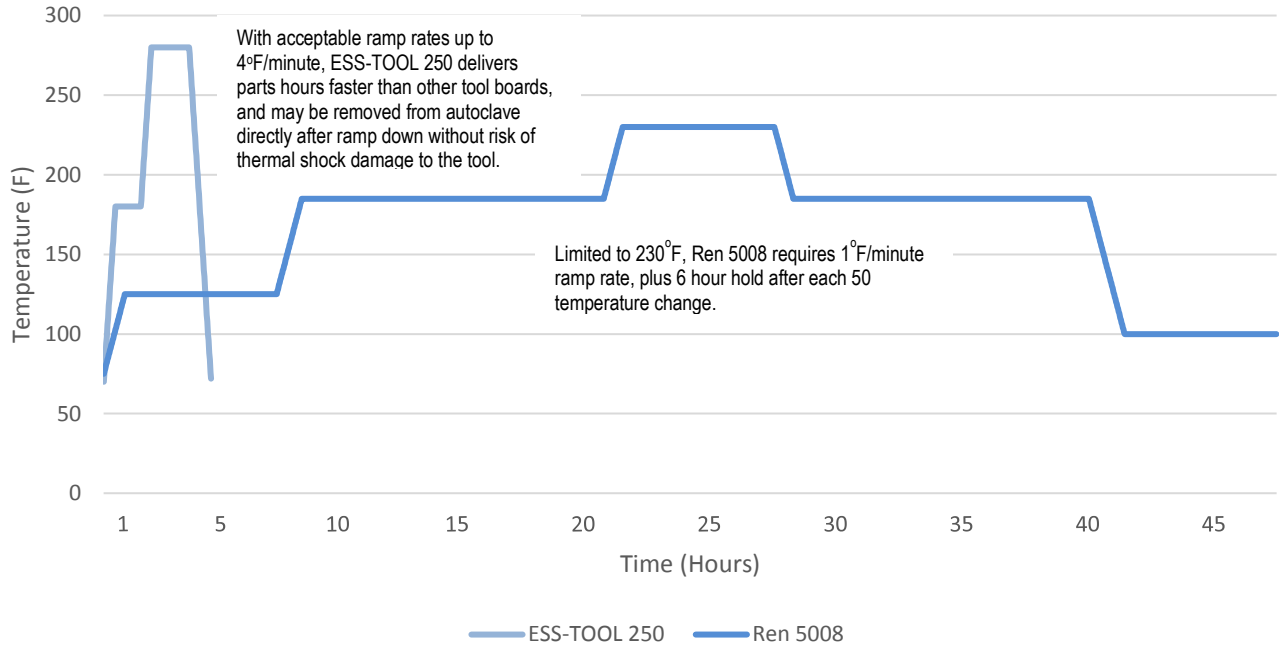
Leveraging 30+ years of experience in materials science, Engineered Syntactic Systems developed ESS-TOOL 250 tooling board for the composites industry. This tough, yet easily machined, material is an excellent choice for composite fabrication in pre-preg and autoclave cure, wet lay-up, vacuum infusion and other composite processes.

- Low, isotropic coefficient of thermal expansion (CTE)
  - 32% lower than leading competitive board
- Dust-free machining
  - Machines in ½ the time of leading competitive board
- Smooth surface easily polished to a Class A finish
- Crack resistant formulation to eliminate thermal shock cracking
  - Suitable for use up to 275°F
- Stress relieved, tightly dimensioned for improved bonding
- Specifically matched bonding adhesive
  - Eliminates stress and reduces potential for mark off

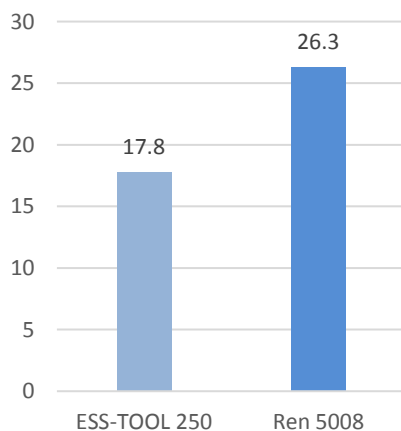
We know that change is difficult. We offer specifics all the way asking only that you truly try it our way when processing ESS-TOOL materials. Proven bonding methods, different cutting tools, faster machining rates, reduced polishing, faster curing ramp rates, lower costs.

You'll find it worth the reward.

## Typical Prepreg Cure Cycle with Improved Ramp Time and No Required Extra Soaks Finishes 40 hours faster than leading competitor

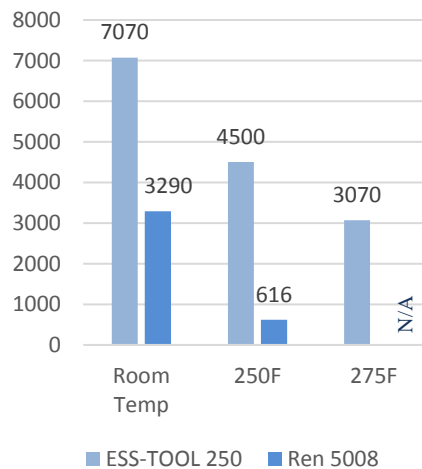


### Room Temp to 250F ( $\times 10^{-6}$ in/in/F)



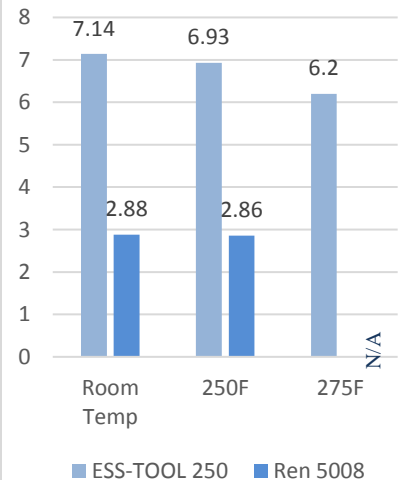
CTE of ESS-TOOL 250, 32% lower than Ren 5008, contributes both to part quality and low stress in the tool during cure.

### Tensile Strength (psi)



Tensile Strength of and Flexural Toughness of ESS-TOOL 250 were developed to ensure tooling board ability to withstand the rigors of prepreg chemistry and challenging cure cycles.

### Flexural Toughness (psi)



# ESS-TOOL<sup>®</sup> 250: PERFORMANCE PROPERTIES THAT MATTER

Property		Value	Units (IMP)	ASTM Test Method	Why it matters
Mechanical	Color	Light Blue-Gray			First line of defense for product identification
	Density	52	lbs/ft <sup>3</sup>		Light, blown foams cannot match critical isotropic properties required for consistent composite production
	Shore Hardness	84 D		D2240	Indicates a relatively “hard” material providing an excellent tool surface for part quality and ease in demolding.
	Tensile Strength @ Room Temperature	7,070	psi	D638	Designed to maintain high tensile and flex strength to reduce cracking at prepreg processing conditions, specifically the complicated stress conditions caused by heating and cooling ramp rates on large and complex tools.
	Tensile Strength @ 275 <sup>o</sup> F	3,070	ksi	D638	
	Flexural Strength @ Room Temperature	8,378	psi	D790	
	Flexural Strength @ 275 <sup>o</sup> F	7,476	psi	D790	
	Flexural Toughness @ Room Temperature	7.14	psi	D790	
	Flexural Toughness @ 275 <sup>o</sup> F	6.2	psi	D790	
	Uniaxial Compressive Strength (Max)	8,590	psi	D695	High strength and stiffness to insure tool durability throughout its life.
Uniaxial Compressive Modulus	690	ksi	D695		
Thermal	Coefficient of Thermal Expansion (RT – 250°F)	17.8 x 10 <sup>-6</sup>	in/in/°F	E228	Controls critical part dimensions AND stresses created at bond lines. It also plays a critical role in minimizing residual stress during board manufacturing. CTE is only meaningful if measured over full temperature span of composite cure cycle
	Glass Transition Temperature (via DSC)	327	°F		Retains properties well above typical prepreg processing temperatures
	Heat Deflection Temperature (264 psi)	272	°F	D648	Limits deformation of mold during cure cycle/use
Size	Standard Dimensional Size (Custom cutting services available)	24" x 60" sheet (610 mm x1524 mm) Thickness of 2" or 4" (50 or 100 mm)			
General	Bonding	ESS-BOND <sup>®</sup> 250		Works with the tool board to create a strong interface and mimics tool board formulation to minimize mark off.	
	Storage	Store flat in a dry place. ESS-TOOL 250 is not temperature sensitive, but should be at ambient room temperature for machining. Do not store in direct sunlight.			

## ESS-BOND® 250: Matched Epoxy Adhesive

ESS-BOND® 250 is specifically formulated for use in bonding and repairing ESS-TOOL® 250 tooling board. The adhesive provides a close match to the properties of ESS-TOOL® 250 to minimize the impact of bond lines and provide the durability to survive critical composite cure cycles. The low viscosity formulation is easy to mix, apply and work with.

### TYPICAL PROPERTIES





Property		Value	Units (IMP)	Value	Units (SI)
Physical Properties	Color	Light Blue-Gray			
	Specific Gravity (of Cured Adhesive)	55	lb/ft <sup>3</sup>	880	kg/m <sup>3</sup>
	Shore D Hardness	85			
	Mixed Viscosity at 77°F (Brookfield DV-II + Pro RV Unit with Spindle #21 at 3rpm)	34,000	cps	34,000	mPa-s
	Coefficient of Thermal Expansion (72°F to 250°F)	43 x 10 <sup>-6</sup>	in/in/°F	77 x 10 <sup>-6</sup>	m/m/°C
Mixing & Application	Mix Ratio	80 Parts A / 20 Parts B			
	Working Time (temperature & mass dependent)	100 grams at 72°F		Approx. 120 minutes	
		650 grams (1 Quart) at 72°F		Approx. 30 minutes	
	Tack/Sanding Time at 72°F	16 Hours			
	Final Cure	Heat cure at 160°F for 6 hours following cure cycle recommendations (before tool is used)			
Packaging	Standard Packaging	1 Gallon Kit: 4.60 lbs Part A / 1.15 lbs Part B Approx. 0.10 ft <sup>3</sup> (175 in <sup>3</sup> ) of Total Adhesive			
General	Storage	Adhesive should be stored in a dry place, in the sealed original containers. Storage temperatures should be 55°F to 85°F (13°C to 29°C). Under these storage conditions, shelf life is 1 year.  Material should be allowed to reach 65°F to 85°F (18°C to 29°C) prior to use.			

**NOTE:** ESS-TOOL products are engineered for performance in processing and in composite fabrication. This requires a change in machining settings and tool choice.

Do not use insert mills as these will not provide the desired performance.



# Machining Guidelines

Cutter Type	<ul style="list-style-type: none"> <li>• <b>2-flute, plastic cutting tools.</b> (4-flute or metal cutting tools are slower due to the smaller chip size typically resulting in a rougher surface and longer run time.)</li> <li>• <b>DO NOT USE INSERT MILLS.</b> These create dust and poor surface quality.</li> <li>• <b>Climb Milling</b> is preferred over Conventional Milling to take a larger chip and extend tool life.</li> <li>• <b>Solid Carbide or Solid Carbide with ZrN coating.</b> (HSS tools dull quickly, resulting in poor surface quality.)</li> <li>• <b>SHARP TOOLS</b> are required. A sharp tool running at correct feeds and speeds stays at or near room temperature. A dull tool quickly heats up and degrades machined surface quality.</li> </ul>																																													
Chip Load Calculations	<ul style="list-style-type: none"> <li>• <b>Use Chip Load</b> to calculate and optimize specific settings for your milling/routing machinery: <i>Feed Rate = Chip Load x Spindle RPM x # of Flutes</i></li> <li>• <b>For Upcut End Mills shown below,</b> Chip Load is typically 0.020 or higher for roughing and 0.005 for finishing with tools diameters &gt; 3/8".</li> <li>• <b>For Ball Mills shown below,</b> Chip Load is typically .007 or higher for roughing and .003 or higher for finishing with tool diameters greater than 1/4".</li> </ul>																																													
	<p>For material removal, slotting or profiling:</p> <p style="text-align: center;"><b><u>2 flute up-cut spiral</u></b></p> <div style="display: flex; justify-content: space-around; align-items: center;">   </div> <p style="text-align: center;"><i>Pictured: 52-7XX series, Onsrud Tool "ZrN" Coating option extends tool life if desired.</i></p> <table border="1" style="width: 100%; text-align: center; border-collapse: collapse;"> <thead> <tr> <th></th> <th colspan="8"><b>Spindle RPM</b></th> </tr> <tr style="background-color: #cccccc;"> <th></th> <th>2500</th> <th>5,000</th> <th>7,500</th> <th>10,000</th> <th>12,500</th> <th>15,000</th> <th>17,500</th> <th>20,000</th> </tr> </thead> <tbody> <tr> <td></td> <td colspan="8"><i>Feed Rate in inches/minute</i></td> </tr> <tr style="background-color: #cccccc;"> <td><b>Finishing</b></td> <td>25</td> <td>50</td> <td>75</td> <td>100</td> <td>125</td> <td>150</td> <td>175</td> <td>200</td> </tr> <tr style="background-color: #cccccc;"> <td><b>Roughing</b></td> <td>100</td> <td>200</td> <td>300</td> <td>400</td> <td>500</td> <td>600</td> <td>700</td> <td>800</td> </tr> </tbody> </table> <p style="text-align: center;"><i>Radial depth of cut = 100%      Axial depth of cut = 1 x D</i></p>		<b>Spindle RPM</b>									2500	5,000	7,500	10,000	12,500	15,000	17,500	20,000		<i>Feed Rate in inches/minute</i>								<b>Finishing</b>	25	50	75	100	125	150	175	200	<b>Roughing</b>	100	200	300	400	500	600	700	800
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Speed and Feed	<p>For 3D contouring:</p> <p style="text-align: center;"><b><u>High finish ball nose</u></b></p> <div style="display: flex; justify-content: space-around; align-items: center;">   </div> <p style="text-align: center;"><i>Pictured: 65-2XX series, Onsrud Tool "ZrN" Coating option extends tool life if desired.</i></p> <table border="1" style="width: 100%; text-align: center; border-collapse: collapse;"> <thead> <tr> <th></th> <th colspan="8"><b>Spindle RPM</b></th> </tr> <tr style="background-color: #cccccc;"> <th></th> <th>2500</th> <th>5,000</th> <th>7,500</th> <th>10,000</th> <th>12,500</th> <th>15,000</th> <th>17,500</th> <th>20,000</th> </tr> </thead> <tbody> <tr> <td><i>Chip Load</i></td> <td colspan="8"><i>Feed Rate in inches/minute</i></td> </tr> <tr style="background-color: #cccccc;"> <td><b>Finishing</b></td> <td>15</td> <td>30</td> <td>45</td> <td>60</td> <td>75</td> <td>90</td> <td>105</td> <td>120</td> </tr> <tr style="background-color: #cccccc;"> <td><b>Roughing</b></td> <td>35</td> <td>70</td> <td>105</td> <td>140</td> <td>175</td> <td>210</td> <td>245</td> <td>280</td> </tr> </tbody> </table> <p style="text-align: center;"><i>Radial depth of cut = 33%      Axial depth of cut = up to 2 x D</i></p>		<b>Spindle RPM</b>									2500	5,000	7,500	10,000	12,500	15,000	17,500	20,000	<i>Chip Load</i>	<i>Feed Rate in inches/minute</i>								<b>Finishing</b>	15	30	45	60	75	90	105	120	<b>Roughing</b>	35	70	105	140	175	210	245	280
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Coolant	<ul style="list-style-type: none"> <li>• None or air. Chips generated must be cleared from the tool area. Re-cutting chips will quickly dull a tool and may create a fire hazard.</li> </ul>																																													
Protection	<ul style="list-style-type: none"> <li>• Safety goggles; enclosed chip space, dust extraction, safety goggles, dust mask, protective gloves</li> </ul>																																													