ENGINEERED SYNTACTIC SYSTEMS

ESS-TOOL™ Composite Syntactic Tool Board

Performance Engineered to Fit Critical Demands

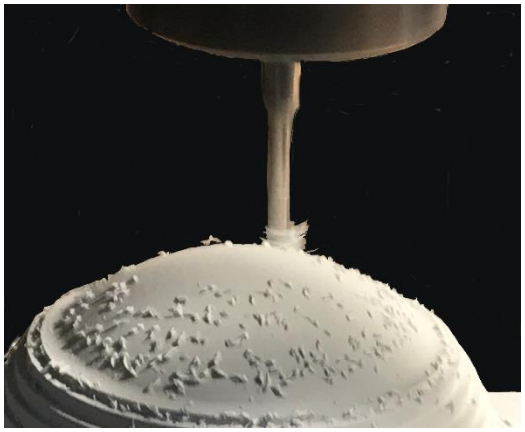
ESS-TOOL™ Performance Engineered Tool Board

Tough. Durable. Low CTE. ESS-TOOL delivers all of the expected quality properties *plus* enhancements to reduce machining time by 60% or more and cure cycle time by 50% or more compared to typical standards.

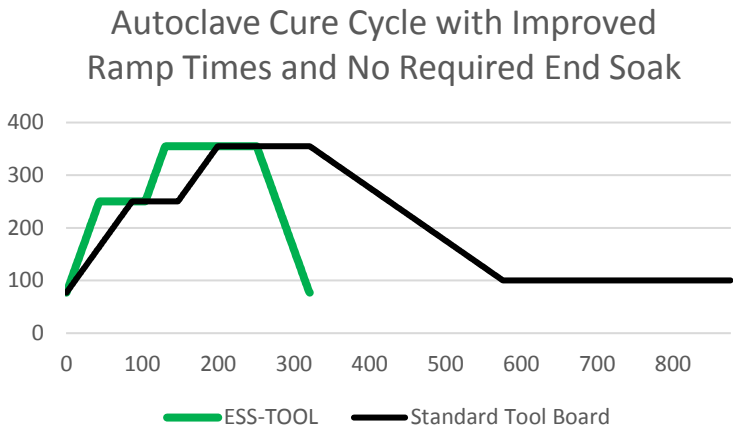
Leveraging 30+ years of experience in materials science, Engineered Syntactic Systems (ESS) has developed a new line of epoxy and thermoplastic tooling boards for the composites industry. These tough and machinable materials are an excellent choice for composite fabrication in pre-preg and autoclave cure, wet lay-up, vacuum infusion and other composite processes. They may also be used for constructing forming tools, master models, fixturing and other heat resistant applications.

- Dust-free machining
- Smoother surface, easily polished to a Class A finish
- Crack resistant formulation to eliminate thermal shock cracking
- Stress relieved, tightly dimensioned for improved bonding
- Matching CTE adhesive to reduce/eliminate 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. Different cutting tools, faster machining feed rates, reduced polishing, faster curing ramp rates, lower costs. You'll find the effort is worth the reward.



ESS-TOOL machines in large chips/flakes at speeds 4X or more than other tooling board materials.



ESS-TOOL 250 @ 4°F/min ramp rate. Acceptable for immediate removal from autoclave at end of cure cycle.

Typical Board @ 2 °F/min maximum ramp rate. Manufacturer recommends 6-hour hold at end of cure cycle to prevent thermal shock.

With acceptable ramp rates up to 4°F/minute, ESS-TOOL 250 delivers parts hours faster than other tool boards, without risk of thermal shock damage to the tool.

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ESS-TOOL 250 Crack-Resistant Epoxy Tooling Board

ESS-TOOL 250 is the newest addition to our tooling board family. With enhanced properties for toughness and durability, it is designed for use at temperatures up to 250°F (121°C). The material is engineered with a unique cell structure to reduce machining time and a polymer system that enhances toughness. The result is faster machinability with superb surface qualities that reduce polishing requirements. The enhanced toughness allows ramp down rates of up to 4°F/minute (2°C). Users can produce models and tools with great precision and dimensional stability.

TYPICAL PROPERTIES

	Property	Value	Units (IMP)	Value	Units (SI)	ASTM Test Method
Mechanical	Color	Light Blue-Gray				
	Density	42.7	lbs/ft3	0.684	g/cm^3	
	Shore Hardness	74 D				D2240
	Uniaxial Compressive Strength (Max)	7,970	psi	55.0	MPa	D695
	Uniaxial Compressive Modulus	314	ksi	2,165	MPa	D695
	Tensile Strength	4,400	psi	30.3	MPa	D638
	Tensile Modulus	140	ksi	965	MPa	D638
	Flexural Strength	5,180	psi	35.7	MPa	D790
	Flexural Modulus	329	ksi	2,268	MPa	D790
Thermal	Coefficient of Thermal Expansion (RT – 250 °F)	25.4 x 10^{-6}	in/in/°F	45.7 x 10^{-6}	m/m/°C	E228
	Thermal Conductivity	.07	BTU/ hr-ft-°F	0.12	W/ m - °K	
	Heat Deflection Temperature (264 psi)	272	°F	133	°C	D648
Size	Standard Dimensional Size (Custom cutting services available)	24" x 60" sheet (610 mm x1524 mm) Thickness of 1", 2", 3" or 4" (25, 50, 75 or 100 mm)				
General	Bonding	ESS-Bond 250, formulated to match physical and thermal properties of ESS-TOOL 250, is recommended to minimize bond line impact.				
	Storage	Store flat in a dry place. ESS-TOOL 250 is not temperature sensitive, but should be at ambient room temperature for machining.				

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ESS-TOOL 705 Impact-Proof Thermoplastic Tooling Board

ESS-TOOL 705 is a new class of tooling board. By using a thermoplastic syntactic structure, 705 triples flexural toughness and impact resistance while maintaining other properties critical to tooling materials. 705 is easily machined and provides excellent edge definition. It is engineered for use in applications where durability is of much greater significance than CTE. ESS-TOOL may be bonded using adhesives and techniques specifically designed for adhesion of thermoplastic materials.

TYPICAL PROPERTIES

	Property	Value	Units (IMP)	Value	Units (SI)	ASTM Test Method
Mechanical	Color	Salmon				
	Density	44	lbs/ft3	705	g/cm^3	
	Shore Hardness	75 D				D2240
	Uniaxial Compressive Strength (Max)	10,215	psi	70.4	MPa	D695
	Uniaxial Compressive Modulus	360	ksi	2,482	MPa	D695
	Tensile Strength	6,100	psi	42.1	MPa	D638
	Tensile Modulus	160	ksi	1,103	MPa	D638
	Flexural Strength	9,050	psi	62.4	MPa	D790
	Flexural Modulus	305	ksi	2,102	MPa	D790
Thermal	Coefficient of Thermal Expansion (RT – 250 °F)	32 x 10^{-6}	in/in/°F	57.6 x 10^{-6}	m/m/°C	E228
	Thermal Conductivity	0.10	BTU /hr ft - °F	0.17	W/ m - °K	
	Heat Deflection Temperature (264 psi)	320	°F	160	°C	D648
	Standard Dimensional Size (Custom cutting services available)	24” x 48” sheet (610 mm x1219 mm) Thickness of 1”, 1.5”, 2”, 2.5”, 3”, 3.5”, 4” or 4.5” (25, 38, 50, 64, 76, 89, 102, 114 mm)				
General	Bonding	EP1320LV, 1 part heat cure epoxy.				
	Storage	Store flat in a dry place. ESS-TOOL 705 is not temperature sensitive, but should be at ambient room temperature for machining.				

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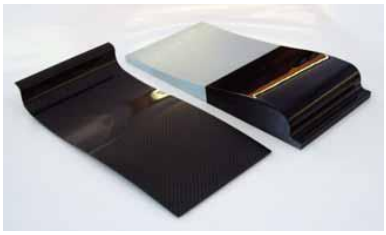

ESS-TOOL 44 Copolymer Tooling Board

ESS-TOOL 44 is a copolymer tooling board designed for low-cost, rapid, dust-free machining and superior surface finish in applications where bonding two or more pieces together is not required. (For applications requiring bonded segments, ESS-TOOL 250 is recommended.) Designed for use at temperatures up to 250°F, (121°C), ESS-TOOL 44 is an excellent choice for composite fabrication in prepreg, autoclave cure, wet layup, vacuum infusion and other composite processes.

	Property	Value	Units (IMP)	Value	Units (SI)	ASTM Test Method
Mechanical	Color	Dark Blue Grey				
	Density	44.0	lbs/ft3	0.704	g/cm^3	
	Shore Hardness	80 D				D2240
	Uniaxial Compressive Strength (Max)	8,010	psi	55.2	MPa	D695
	Uniaxial Compressive Modulus	290	ksi	2,000	MPa	D695
	Tensile Strength	4550	psi	31.4	MPa	D638
	Flexural Strength	6,470	psi	44.6	MPa	D790
	Flexural Modulus	334	ksi	2300	MPa	D790
	Coefficient of Thermal Expansion (RT – 350 °F)	22×10^{-6}	in/in/°F	40×10^{-6}	m/m/°C	E228
General	Standard Dimensional Size (Custom cutting services available)	24" x 60" sheet (610 mm x1524 mm) Thickness of 1", 2", 3", or 4" (25, 50 or 75, 100 mm)				
	Bonding	Not recommended				
	Storage	Store flat in a dry place. ESS-TOOL 44 is not temperature sensitive, but should be at ambient room temperature for machining.				

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

Machining Guidelines

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

Cutter Type	• **2-flute, plastic cutting tools. (**4-flute or metal cutting tools are slower due to the smaller chip size typically resulting in a rougher surface and longer run time.) • **DO NOT USE INSERT MILLS.** These create dust and poor surface quality. • **Climb Milling** is preferred over Conventional Milling to take a larger chip and extend tool life. • **Solid Carbide. (**High speed steel tools will dull quickly, resulting in an inconsistent machined surface.) • **SHARP TOOLS** 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.
Chip Load Calculations	• **Use Chip Load** to calculate and optimize specific settings for your milling/routing machinery: *Feed Rate = Chip Load x Spindle RPM x # of Flutes* • **For Upcut End Mills shown below,** Chip Load is typically 0.020 or higher for roughing and 0.005 for finishing with tools diameters > 3/8". • **For Ball Mills shown below,** Chip Load is typically .007 or higher for roughing and .003 or higher for finishing with tool diameters greater than ¼".

For material removal, slotting or profiling:

2 flute up-cut spiral

Pictured: 52-7XX series, Onsrud Tool
"ZrN" Coating option extends tool life if desired.

	Spindle RPM							
	2500	*5,000*	*7,500*	*10,000*	*12,500*	*15,000*	*17,500*	*20,000*
Chip Load	Feed Rate in inches/minute							
.005	**25**	**50**	**75**	**100**	**125**	**150**	**175**	**200**
.010	**50**	**100**	**150**	**200**	**250**	**300**	**350**	**400**
.020	**100**	**200**	**300**	**400**	**500**	**600**	**700**	**800**
.025	**125**	**250**	**375**	**500**	**625**	**750**	**875**	**1000**

Radial depth of cut = 100% *Axial depth of cut = 1 x D*

Speed and Feed

For 3D contouring:

High finish ball nose

Pictured: 65-2XX series, Onsrud Tool
"ZrN" Coating option extends tool life if desired.

	Spindle RPM							
	2500	*5,000*	*7,500*	*10,000*	*12,500*	*15,000*	*17,500*	*20,000*
Chip Load	Feed Rate in inches/minute							
.003	**15**	**30**	**45**	**60**	**75**	**90**	**105**	**120**
.005	**25**	**50**	**75**	**100**	**125**	**150**	**175**	**200**
.007	**35**	**70**	**105**	**140**	**175**	**210**	**245**	**280**
.010	**50**	**100**	**150**	**200**	**250**	**300**	**350**	**400**

Radial depth of cut = 33% *Axial depth of cut = up to 2 x D*

Coolant	• 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.
Protection	• Safety goggles; enclosed chip space, dust extraction, safety goggles, dust mask, protective gloves

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