

CYCOM[®] X5320

Innovative Approach to Out-of-Autoclave Processing

September 9, 2008

Agenda

- Introduction
- Problem Statement
- Cycom X5320
- Potential Value Proposition
- Solicit input on the interest for Out-of Autoclave



Introduction-Cycom X5320 prepreg

CEM is experienced and capable with OOA

- Material Science – through chemistry and understanding
 - Balanced cure cycles to customer requirements
 - Reduce porosity; control viscosity
 - Tack life and total out-time
 - Maximize mechanical properties that drive key design elements
- Technical Service Support – Global tech support of material selection, lay-up, tooling, and assembly
- Application Engineering – PRIM, Automation (AFP, ATL) - BMI & toughened epoxy

Problem Statement

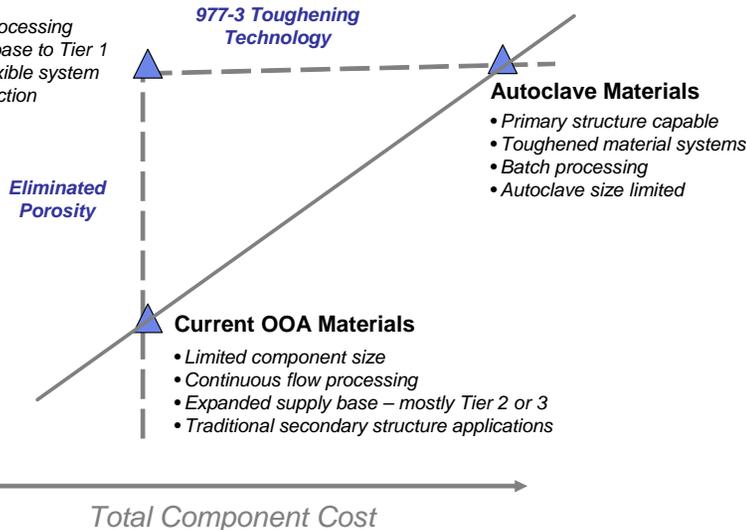
- Progress technology/capability from secondary to primary structure
- Provide material system capable of prototype or production needs

<u>Gaps Today</u>	<u>Specific Limitation</u>	<u>Target</u>
Mechanical performance	secondary structure	primary
Porosity	<4%	<1%
Tack/Handling	<10 days	30 days
Component size	geometry and dimension limited	unlimited
Versatility	lengthy low temp cure varying properties w/cure poor green strength	<12hr initial consistent excellent

Attacking problem through material science

X5320 - *primary structure performance with OOA benefits*

- Potentially unlimited component size
- <1% porosity
- Hot/Wet strength
- Continuous flow processing
- Expanded supply base to Tier 1
- Highly versatile/flexible system
- Prototype to production



- Fundamental material science approach
- 977-3 technology
- Critical in-depth understanding of key OOA characteristics of flow, gel, impregnation, resin advancement
- Versatile, robust manufacturing cure cycle options – providing necessary green strength
- Supported by in-application engineering

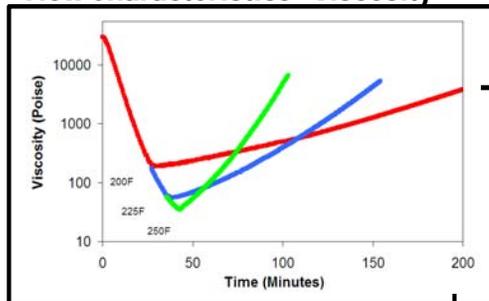
Cycom X5320 Introduction

Breakthrough OOA material – addresses primary structure needs

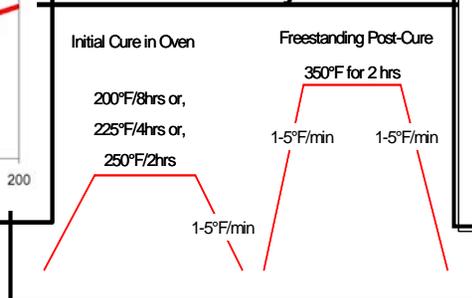
- Legacy military fighter epoxy autoclave mechanical properties with OOA processing
- Large, primary structure component processing
 - Porosity
 - Hot/Wet
- Tailorable handling properties to meet hand-layup and automation part manufacturing
- Prototype parts to high-rate production capable
- Flexible cure cycles providing robust degree of cure with final resin cross-linking

	Current		<u>X5320</u>
	Autoclave	OOA	
Large scale components	✗	✓	☐
Primary structure	✓	✗	☐
Continuous flow process	✗	✓	☐
Hot/Wet strength	✓	✗	☐
Eliminates porosity	✓	✗	☐
Automation	✓	✗	☐

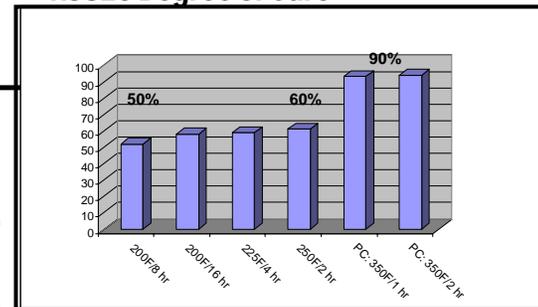
Flow Characteristics - Viscosity



Flexible Cure Cycles



X5320 Degree of Cure



Properties of X5320 limited and preliminary data collection

Properties	977-3 IM fiber	X5320 IM fiber
OHC (220F/Wet) [0/90]3s; ASTM D6484; qty=8	39.3 ksi	42.3 ksi
Tg (Wet) DMA Storage Mod; [0]10	303°F	310°F
OHT (-65F/Dry) [+,0,-,90]3s; ASTM D5766; qty=8	65.4 ksi	75.1 ksi
CAI [+,0,-,90]4s; SRM02R94; qty=8	25.2 ksi	29.6 ksi
Solvent Resistant	Pass	Pass
Initial Cure Temp	355F (autoclave)	200F/16 hours (VBO)

Product Portfolio

Unidirectional Tape

- X5320 T40-800B 145 gsm/33% resin content, 49" width
- X5320 T40-800B 290gsm/33% resin content, 49" width

Fabric

- X5320 WT650-35 3K-8HS 48" width, 36% resin content

Non-Carbon Forms

- X5320 4581Q-9837 38" DP 35% resin content
- X5320 108 50" width, 50% resin content
- X5320 60001 50" width Peel Ply

Ancillary products

Material	Recommended	Target Properties
Film Adhesive	FM300-2K or FM209M	FWT (220F/Wet) Equivalent to FM300 (-65F:800psi, RT:700psi, 250f:500psi)
Foaming Adhesive	FM490A	Similar to FM404A. Passes expansion requirement at 200F of 200%.
Peel Ply	X5320 Peel Ply	Compatible with resin and removes cleanly from part
Syntactic Core	FM381	Density:40 pcf, FWT similar to FM381
Surfacing Film	SM 905M	Clean surface; no surface porosity

Out-of-Autoclave Value Proposition

Performance

- Address porosity and mechanical performance which have historically limited Out-of-Autoclave materials to secondary structures
- Geometrically limited due to part quality of autoclave processing (resin rich, thin out, etc)
- Unitized structure design
- Ability to support rapid, small volume aircraft demonstrations & insertion into production rates

Cost

- Alternative tooling design concepts
- Part count reduction addressing legacy black aluminum designs
- Supply-base capability & expansion
- Lower capital costs for further composite application adoption
- Qualification serves demonstration articles and production

Discussions/Feedback

- Material characteristics
- Material product forms
- Industry Material Specifications – interest, approaches
- Processing constraints, desires
- Database considerations
- Tooling approaches, concerns
- Equipment requirements – ovens, vacuum sources, other heat sources
- Challenging part features for producibility evaluation/scale
- Applications and related constraints/issues
- Variability, robustness
- Further interest?

Please complete the questionnaire provided... your input is essential!