Material Data Files Sets Available with RAVEN and COMPRO

2024

CONVERGENT
MANUFACTURING TECHNOLOGIES
Efficient composites processing

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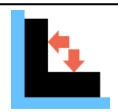
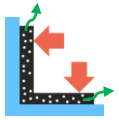
Outcomes by Analysis Type

Legend	
✓	Characterized by Convergent
-	Not Applicable

With Corresponding Convergent Characterization Packages

Outcomes		Analysis Type	Required Material Property Models	Characterized by Convergent	
				Matrix	Composite
	**Thermal Lags** **Exotherms** **Thermal Gradients** **Degree of Cure or Crystallinity**	**Thermal** (Thermo-Chemical or Thermo-Physical)	Degree of Cure or Crystallization	✓	✓
			Heat of Reaction or Heat of Fusion	✓	✓
			Glass Transition	✓	✓
			Density	✓	✓
			Specific Heat Capacity	✓	✓
			Thermal Conductivity	✓	✓
	**Volume Fraction Variation** **Thickness Changes and Gaps**	**Flow-Compaction**	Matrix Viscosity	✓	-
			Fibre Bed Resin Permeability	-	✓
			Fibre Bed Compaction Curve	-	✓
	**Spring-in** **Warpage** **Residual Stress**	**Stress-Deformation**	Elastic / Viscoelastic Constants	✓	✓
			Coefficient of Thermal Expansion (CTE)	✓	✓
			Cure or Crystallization Shrinkage (CS)	✓	-
			Matrix swelling and De-Solvation Shrinkage	✓	-
	**Deposition Wrinkling** **Prepreg Tack and Slip**	**Deposition** (Forming and AFP)	In-Plane Shear	-	✓
			Interlaminar Shear	-	✓
			Prepreg Tack	-	✓
			Ply Bending	-	✓
	**Moisture Content** **Solvent Content** **Surface Tack**	**Diffusion and Drying**	Species Evaporation	✓	✓
			Species Absorption	✓	✓
			Species Diffusion	✓	✓
			Surface Tack	✓	✓
	**Gas Transport** **Off-gassing** **Porosity** **Consolidation Wrinkling**	**Porosity**	Laminate Gas Permeability	-	✓
			Consumables Gas Permeability	-	✓
			Initial Moisture and/or Solvent Content	✓	✓
			Gas Generation	✓	✓
			Fibre Bed Debulk Curve	-	✓

Available Material Data Files

Legend	
✓	Included
×	Not included
-	Not Applicable

Prepregs, Adhesives and Resins: Open

Last Update: 2024-04-10

Manufacturer	Materials		Architecture	Form	Thermal	Flow-Compaction		Stress-Deformation	Porosity	Deposition	Source
	Matrix	Fibre				Fibre Bed	Viscosity				
ACG	MTM45-1	HTS5631	UD	Prepreg	✓	×	✓	×	×	×	Convergent
Cytec	5320	T650	UD	Prepreg	✓	×	✓	×	×	×	Open Literature [8]
Gurit	PRIME 130 SPX26528 /Fast SPX26180	-	-	Resin	✓	-	✓	×	×	-	Open Literature [13]
Gurit	PRIME 130 SPX26528/ Standard SPX26373	-	-	Resin	✓	-	✓	×	×	-	Open Literature [13]
Hexcel	3501-6	AS4	UD	Prepreg	✓	✓	✓	✓	×	×	Open Literature [2] [11]
Hexcel	8551-7	AS4	UD	Prepreg	✓	×	✓	✓	×	×	Open Literature [3] [4]
Hexcel	8552	-	-	Resin	✓	-	✓	✓	✓	-	Convergent
Hexcel		AS4	Fabric	Prepreg	✓	✓	✓	✓	×	×	Open Literature [1]
Hexcel		AS4	UD	Prepreg	✓	✓	✓	✓	✓	×	Convergent
Hexcel		IM7	UD	Prepreg	✓	×	✓	×	×	×	Convergent
Hexcel	8552-1	IM7	UD	Prepreg	✓	✓	✓	✓	✓	×	Convergent US
Hexcel	M21	-	-	Resin	✓	-	×	×	×	-	Open Literature [14]
Hexcel		IMA	UD	Prepreg	✓	×	×	×	×	×	Open Literature [14]
Hexion	Epikote 50475	-	-	Resin	✓	-	✓	×	×	-	Open Literature [13]
Olin	Airstone 750E/785H	-	-	Resin	✓	-	✓	×	×	-	Open Literature [13]
ProSet	INF 114/212	-	-	Resin	✓	-	×	✓	×	-	Convergent
Solvay	5215	T40	UD	Prepreg	✓	×	✓	×	×	×	Convergent
Solvay	5250-5	T650	UD	Prepreg	✓	×	✓	×	×	×	Convergent
Solvay	5320-1	-	-	Resin	✓	-	✓	×	×	-	Convergent
Solvay		IM7	UD	Prepreg	✓	×	✓	×	×	×	Convergent
Solvay	890RTM	-	-	Resin	✓	-	✓	✓	×	-	Open Literature [9]
Solvay		AS4	Fabric	Prepreg	✓	×	✓	✓	×	×	Open Literature [9]
Solvay	EP2190	-	-	Resin	✓	-	✓	×	×	-	Convergent
Solvay		HTS45	UD	Prepreg	✓	×	✓	×	×	×	Convergent
Solvay		IMS65	UD	Prepreg	✓	×	✓	×	×	×	Convergent
Solvay		T650	Fabric	Prepreg	✓	×	✓	×	×	×	Convergent
Solvay	FM300-2	-	-	Film Adhesive	✓	-	✓	×	×	-	Convergent

Available Material Data Files

Legend	
✓	Included
×	Not included
-	Not Applicable

Prepregs, Adhesives and Resins: Open

Last Update: 2024-04-10

Manufacturer	Materials		Architecture	Form	Thermal	Flow-Compaction		Stress-Deformation	Porosity	Deposition	Source
	Matrix	Fibre				Fibre Bed	Viscosity				
Solvay	FM309-1	-	-	Film Adhesive	✓	-	✓	×	×	-	Convergent
Solvay	PEEK	AS4	UD	Prepreg	✓	×	×	✓	×	×	Open Literature [5] [6]
Teijin	Q183	-	-	Resin	✓	-	✓	×	×	-	Convergent
Teijin		IMS65	UD	Prepreg	✓	×	✓	×	×	×	Convergent
Toray	3900-2	-	-	Resin	✓	-	✓	✓	×	-	Open Literature [7]
Toray		T800H	UD	Prepreg	✓	×	×	×	×	×	Open Literature [7]
Toray	2510U	T700	UD	Prepreg	✓	×	✓	×	×	×	Convergent
Toray	BTCy-1	-	-	Resin	✓	-	✓	✓	×	-	Convergent
Toray		Astroquartz III	8HS	Prepreg	✓	×	✓	✓	×	×	Convergent
Toray	RS-3C	-	-	Resin	✓	-	✓	✓	×	-	Convergent
Toray		M55J	Fabric	Prepreg	✓	✓	✓	✓	×	×	Convergent
Toray		M55J	UD	Prepreg	✓	✓	✓	✓	×	×	Convergent
Toray	TC1200 (PEEK)	AS4	UD	Prepreg	✓	×	✓	×	×	×	CRN / Convergent
Toray	TC250	AS4C	Fabric	Prepreg	✓	×	✓	×	×	×	Convergent
Toray		AS4C	UD	Prepreg	✓	×	✓	×	×	×	Convergent
Toray	TC275-1	HTS40	Fabric	Prepreg	✓	×	✓	×	×	×	Convergent
Toray		TR50S	UD	Prepreg	✓	×	✓	×	×	×	Convergent
Toray	TC380	-	-	Resin	✓	-	✓	×	×	-	Convergent
Toray		HM63	UD	Prepreg	✓	×	✓	×	×	×	Convergent
Toray		IM7	Fabric	Prepreg	✓	×	✓	×	×	×	Convergent

Available Material Data Files

Legend	
✓	Included
×	Not included
-	Not Applicable

Prepregs, Adhesives and Resins: By Request

Last Update: 2024-04-10

Manufacturer	Materials		Architecture	Form	Thermal	Flow-Compaction		Stress-Deformation	Porosity	Deposition	Source
	Matrix	Fibre				Fibre Bed	Viscosity				
Toray	2511	T800H	Fabric	Prepreg	✓	×	✓	×	×	×	Convergent
Toray	2700	-	-	Resin	✓	×	✓	✓	-	-	Convergent
Toray		T700G	UD	Prepreg	✓	×	✓	✓	×	×	Convergent
Toray		T700S	Fabric	Prepreg	✓	×	✓	✓	×	×	Convergent
Toray	3900-2	E-Glass	Fabric	Prepreg	✓	×	✓	✓	×	×	Convergent
Toray	3900-2B	T800S	UD	Prepreg	✓	✓	✓	×	✓	×	Convergent
Toray	3900-2C	T800S	UD	Prepreg	✓	×	✓	✓	×	×	Convergent
Toray	3900-2D	T830H	Fabric	Prepreg	✓	×	✓	✓	×	×	Convergent
Toray	3960	T1100G	UD	Prepreg	✓	×	✓	✓	×	×	Convergent
Toray	G83CM	-	-	Resin	✓	×	✓	×	-	-	CRN
Toray		T700G	UD	Prepreg	✓	×	✓	×	×	×	CRN
Toray	TC1225	T1100G	UD	Prepreg	✓	×	✓	✓	×	×	Convergent
Toray	TC275	HTS40	Fabric	Prepreg	✓	×	✓	×	×	×	Convergent
Toray		TR50S	UD	Prepreg	✓	×	✓	×	×	×	Convergent

Available Material Data Files

Legend	
✓	Included
×	Not included
-	Not Applicable

Other: Open

Last Update: 2024-04-10

Manufacturer	Materials	Architecture	Form	Thermal	Flow-Compaction		Stress-Deformation	Porosity	Deposition	Source
					Fibre Bed	Viscosity				
Diab	DIAB ProBalsa Core	-	Core	✓	-	-	×	×	-	Convergent
Hexcel	3/16-5052-.001 Honeycomb (Aluminium)	Honeycomb	Core	✓	-	-	✓	×	×	Convergent
Hexcel	3/16-5052-.003 Honeycomb (Aluminium)	Honeycomb	Core	✓	-	-	✓	×	×	Convergent
Hexcel	HRH-10 3/16-1.5 Honeycomb (Aramid)	Honeycomb	Core	✓	-	-	✓	×	×	Convergent
Hexcel	HRH-10 3/16-6.0 Honeycomb (Aramid)	Honeycomb	Core	✓	-	-	✓	×	×	Convergent
Hexcel	HRP 3/16-12.0 Honeycomb (Fiberglass)	Honeycomb	Core	✓	-	-	✓	×	×	Convergent
Hexcel	HRP 3/16-4.0 Honeycomb (Fiberglass)	Honeycomb	Core	✓	-	-	✓	×	×	Convergent
Visight	VICELL PET Core T100	Foam	Core	✓	-	-	×	×	-	Convergent
Visight	VICELL PET Core T105	Foam	Core	✓	-	-	×	×	-	Convergent
Visight	VICELL PET Core T115	Foam	Core	✓	-	-	×	×	-	Convergent
Visight	VICELL PET Core T135	Foam	Core	✓	-	-	×	×	-	Convergent
Visight	VICELL PET Core T200	Foam	Core	✓	-	-	×	×	-	Convergent
DSP	DSP70GP Silicone Sheeting	-	Other	✓	-	-	×	×	-	Convergent
Generic	Borosilicate Glass	-	Other	✓	-	-	×	×	-	Convergent
Generic	Nominal Breather	-	Other	✓	-	-	✓	×	×	Convergent
Generic	Nominal Rubber	-	Other	✓	-	-	✓	×	×	Convergent
Kflex Solar	K-FLEX Solar HT Foam Rubber Insulation	Foam	Other	✓	-	-	×	×	-	Convergent

Available Material Data Files

Legend	
✓	Included
×	Not included
-	Not Applicable

Tooling: Open

Last Update: 2024-04-10

Manufacturer	Materials	Architecture	Form	Thermal	Flow-Compaction		Stress-Deformation	Porosity	Deposition	Source
					Fibre Bed	Viscosity				
CFOAM	CFOAM 20	Foam	Tooling	✓	-	-	×	×	-	Convergent
CFOAM	CFOAM 25	Foam	Tooling	✓	-	-	×	×	-	Convergent
CFOAM	CFOAM 30	Foam	Tooling	✓	-	-	×	×	-	Convergent
Generic	Aluminium 606x	-	Tooling	✓	-	-	×	×	-	Convergent
Generic	Copper	-	Tooling	✓	-	-	×	×	-	Convergent
Generic	Invar 36	-	Tooling	✓	-	-	×	×	-	Convergent
Generic	Nickel 200	-	Tooling	✓	-	-	×	×	-	Convergent
Generic	CFRP (Bi-axial Fabric)	Fabric	Tooling	✓	-	-	×	×	-	Convergent
Generic	CFRP (Quasi-iso Laminate)	Quasi-Iso	Tooling	✓	-	-	×	×	-	Convergent
Generic	CFRP (UD Tape)	UD	Tooling	✓	-	-	×	×	-	Convergent
Generic	GFRP (Bi-axial Fabric)	Fabric	Tooling	✓	-	-	×	×	-	Convergent
Generic	GFRP (Quasi-iso Laminate)	Quasi-Iso	Tooling	✓	-	-	×	×	-	Convergent
Generic	GFRP (UD Tape)	UD	Tooling	✓	-	-	×	×	-	Convergent
Generic	Steel 1020	-	Tooling	✓	-	-	×	×	-	Convergent
RenShape	RenShape 5065	-	Tooling	✓	-	-	×	×	-	Convergent

List of Open Literature Sources

[1] A. Johnston. An integrated model of the development of process-induced deformation in autoclave processing of composite structures. PhD Thesis. The University of British Columbia, Vancouver, Canada (1997).

[2] P. Hubert. Aspects of flow and compaction of laminated composite shapes during cure. PhD Thesis. The University of British Columbia, Vancouver, Canada (1996).

[3] Jackson, WC and Ifju, PG, "Through-the-Thickness Tensile Strength of Textile Composites", Composite Materials: Testing and Design (Twelfth Volume) ASTM STP 1274, RB Deo and CR Saff, Eds., ASTM, 1996, pp. 213-238

[4]

- Cure Kinetics: Based on SMS paper (r=0.83 from PMS paper)
- Modulus (E): Based on SMS paper
- PR (v): Unknown, typical used
- Cure Shrinkage: consistent w CTE
- CTE: PMS paper, Fig2
- Density (ro): Unknown, typical used
- Viscosity: 8552 values used
- Heat Capacity: 8552 values used
- Conductivity: 8552 values used

[5] Sun, CX, and Yoon, KJ (1991) "Characterization of Elastic Plastic Behavior of AS4/PEEK Thermoplastic Composite for Temperature Variation" Journal of Composite Materials, Vol 25, p1297

[6] Based on 4 papers:

- 1. W.I. Lee and G.S. Springer. A Model of the Manufacturing Process of Thermoplastic Matrix Composites. Journal of Composite Materials: 21(11); p.1017-1055 (1987).
- 2. S.C. Mantell and G.S. Springer. Manufacturing Process Model for Thermoplastic Composites. Journal of Composite Materials: 26(16); p.2348-2377 (1992).
- 3. C.N. Velisaris and J.C. Seferis. Crystallization Kinetics of Polyetheretherketone (PEEK) Matrices. Polymer Engineering and Science: 26(22); p.1574-1581 (1986).
- 4. T.J. Chapman, J.W. Gillespie Jr, R.B. Pipes, J.-A.E. Manson and J.C. Seferis. Prediction of Process-Induced Residual Stresses in Thermoplastic Composites. Journal of Composite Materials: 24(6); p.616-643 (1990).

[7] Dykeman, D. Minimizing Uncertainty in Cure Modeling For Composites Manufacturing. PhD Thesis. The University of British Columbia, Vancouver, Canada (2008).

[8] Kratz J, Hsiao K, Goran F, Hubert P. Thermal models for MTM45-1 and Cycom 5320 out-of-autoclave prepreg resins. J Compos Materials, V.47, n.3, pp.341-352, 2013.

[9] Khoun, L. Process-Induced Stress and Deformations in Woven Composites Manufactured by Resin Transfer Moulding. PhD Thesis. Department of Mechanical Engineering McGill University, Montreal, Quebec, Canada (2009).

List of Open Literature Sources

[10] Thorpe, R. Experimental characterization of the viscoelastic behavior of a curing epoxy matrix composite from pre-gelation to full cure. Master of Applied Science Thesis. The University of British Columbia, Vancouver, Canada (2013).

- Cure Kinetics: Based on NCAMP/NIAR MTM45-1 model
- Density (ro): MTM45-1 Datasheet
- Viscosity: Based on NCAMP/NIAR MTM45-1 model
- Heat Capacity: Based on NCAMP/NIAR MTM45-1 model
- Conductivity: Typical value used
- Modulus (E): R. Thorpe thesis
- PR (v): R. Thorpe thesis
- Cure Shrinkage: Fit to R. Thorpe thesis data
- CTE: Fit to R. Thorpe thesis data

[11] Kim and White – Source needed

[12] Svanberg, J.M., and Holmberg, J.A., Prediction of shape distortions. Part II. Experimental validation and analysis of boundary conditions, Composites Part A, V 35, pp. 723-734, (2004).

- Only modulus and Poisson's ratio were taken from the paper
- Cure Kinetics: MTM45-1 models use with Tg model adjusted to match the modulus model

[13] Barcenas L, Narayana SS, Khoun L, Trudeau P, Hubert P. "Thermochemical and rheological characterization of highly reactive thermoset resins for liquid moulding. Journal of Composite Materials. 2023;57(19):3013-3024.

[14] Mesogitis, T., Kratz, J., & Skordos, A. A. (2019). Heat transfer simulation of the cure of thermoplastic particle interleaf carbon fibre epoxy prepregs, Journal of Composite Materials, 53(15), 2053–2064.