AZL Aachener Zentrum für integrativen Leichtbau
RWTH AACHEN UNIVERSITY

Material Data Sheet Study

Standardization for RTM Data Sheets

07/11/2014, Aachen
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Motivation – Lightweight Design



Aerospace → Aviation → Premium Automotive → Standard Automotive

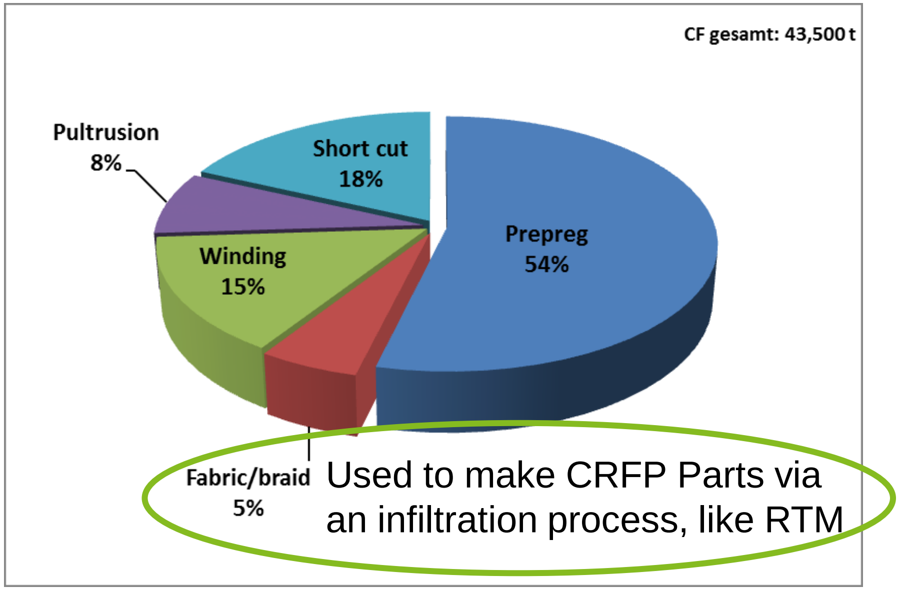
Acceptable cost for weight reduction in €/kg	
Aerospace	5.000
Wide-bodied aircraft	500
Premium-KFZ (longterm)	8-20
Compact- and medium class (longterm)	5-14

- Fully automated and cost-effective
- Best surface quality
- Effective mechanical properties

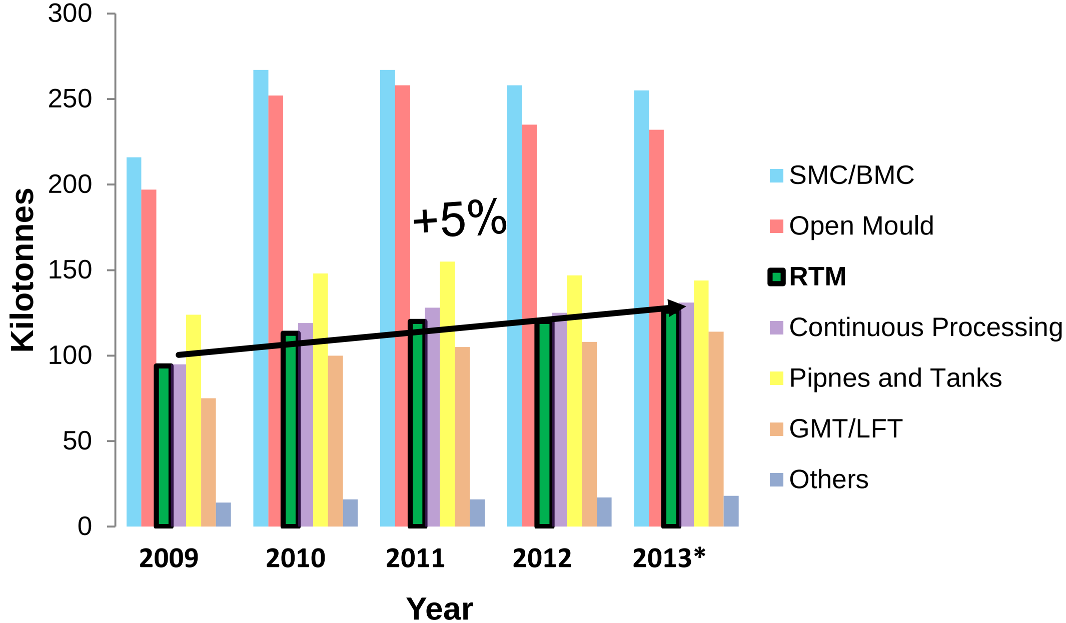
Resin Transfer Moulding (RTM)

[DLR Institut für Faserverbundleichtbau und Adaptronik 2003, Mc Kinsey 2012, EADS, Airbus, Audi, Mercedes-Benz, Schuler, IKV]

Market Overview



Market shares of the manufacturing processes / Semi-finished products for CFRP (2012) [MTP, Ind.Exp., AVK13]



GFRP production volumes in Europe itemised by procedures/components (2013* = estimate) [AVK13]

Exemplary Machinery Manufacturer:

Summary of the 1st RTM-Workshop

- Derived needs for the future composite market are:
  - **“Methodology same as steel”**, faster development, no overcharging of customers and better acceptance for composites
  - Identification of particular drawbacks, perfect material characteristics and generating **knowledge to realize benefit-cost analysis and to calculate cost break even points**
  - **Special formulations with characteristics, adjusted to the process** to improve process difficulties and to lower costs. E.g. lower viscosities which allow the use of less pressures and thus, less expensive equipment costs
  - Possibility to use different material systems with the same equipment to ensure investments
- To fulfill these needs of the composites manufacturing, considered cooperative aims of the AZL-partners are:
  - Benchmark of the different process chains, concerning manufacturing and material technologies
  - **Implementation of standards, like standardized material data sheets for simulations and design to realize a more industrialized composite market and to accelerate composite developments**

Content

Motivation
Standards

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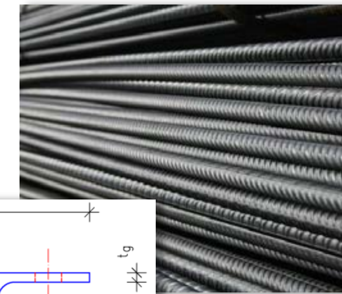
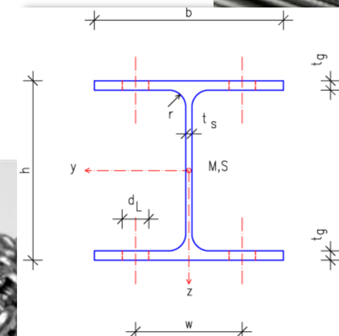
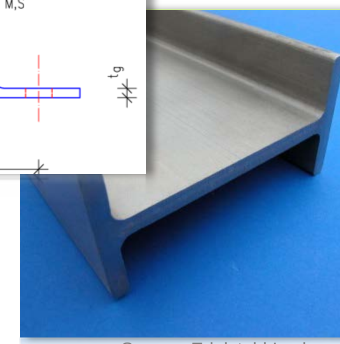
- Why do we need standards?
  - Faster product development processes
  - Better process adaptability for defined assemblies, mixtures, etc.
  - Easier quality assurance
  - Wider spread market,
    extending industry sectors



Source: Progress



Source: Dontscrapit



Source: Edelstahl Lechner

- Push for new technologies into broader applications
- Lower entry barriers to new markets
- Increasing selling and distribution

[…]

Motivation
Challenges of Composites

Composites and Standards

- Composite materials have nearly infinite combinations possible by varying fiber types, resin systems, fiber loadings, fiber architectures, fiber sizings, cooling rates, mold pressures, etc., resulting in largely varying properties **for the same fiber/resin combination**.
- While this large range of achievable properties allows for a high degree of optimization of composites for high performance applications, **it hinders the adoption of composites in high volume production industries such as automotive**.

Source: BMW

Source: Bike components

Source: Dorint-Blog

Source: John - Fotolia.com

Motivation

Needed Information for the Supply Chain

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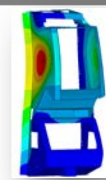
Resin system supplier

Source: Dotmar

- Info for distribution and selection process/ advertisement of his products
  - Mechanical & process properties
  - Packaging
  - Delivery
  - Storage

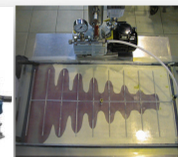
Designer



Source: IKV

- Simulation input values for the use of design and process models
  - Mechanical characteristics
  - Process dependent and changing values

Machine tool manufacturer & Manufacturer



Source: IKV

- Tool design
  - Injection process
  - Sealing concept
- Mixing unit & dosing system
- Information for process applicability, e.g.
  - Viscosity
  - Gel time
  - T_g
  - Curing cycle information

User

Source: BMW

- Handling properties
- Recycling
- Environmental compatibility
- Certifications and seal of quality
- **Standards**

Motivation

Needed Information for the Supply Chain

Resin system supplier

Designer

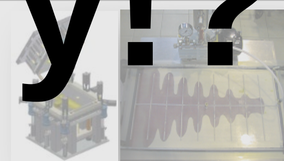
Machine tool manufacturer & Manufacturer

User

Theory!?

Source: Dotmar

Source: IKV



Source: IKV

Source: BMW

User

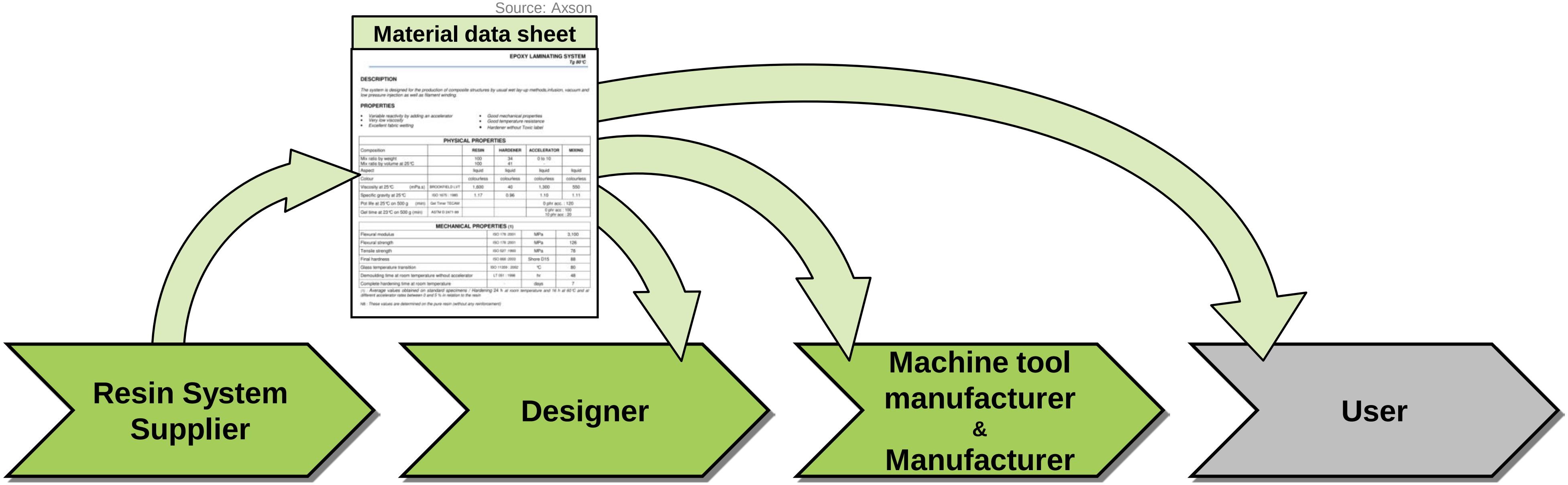
Resin system supplier

Designer

Machine tool manufacturer & Manufacturer

Motivation
Material Data Sheet

Source: Axson



- Resin-system suppliers provide a material data sheet
- Data is used by all further participants in the supply chain
- Demands on product data from participants are diverse

Difficulty to match complex needs of participants

Development of a standardized material data sheet regarding the needs of all participants

Material Data Sheet Study

Content

Overview of Material Data Sheets

Current Data Sheet Analysis

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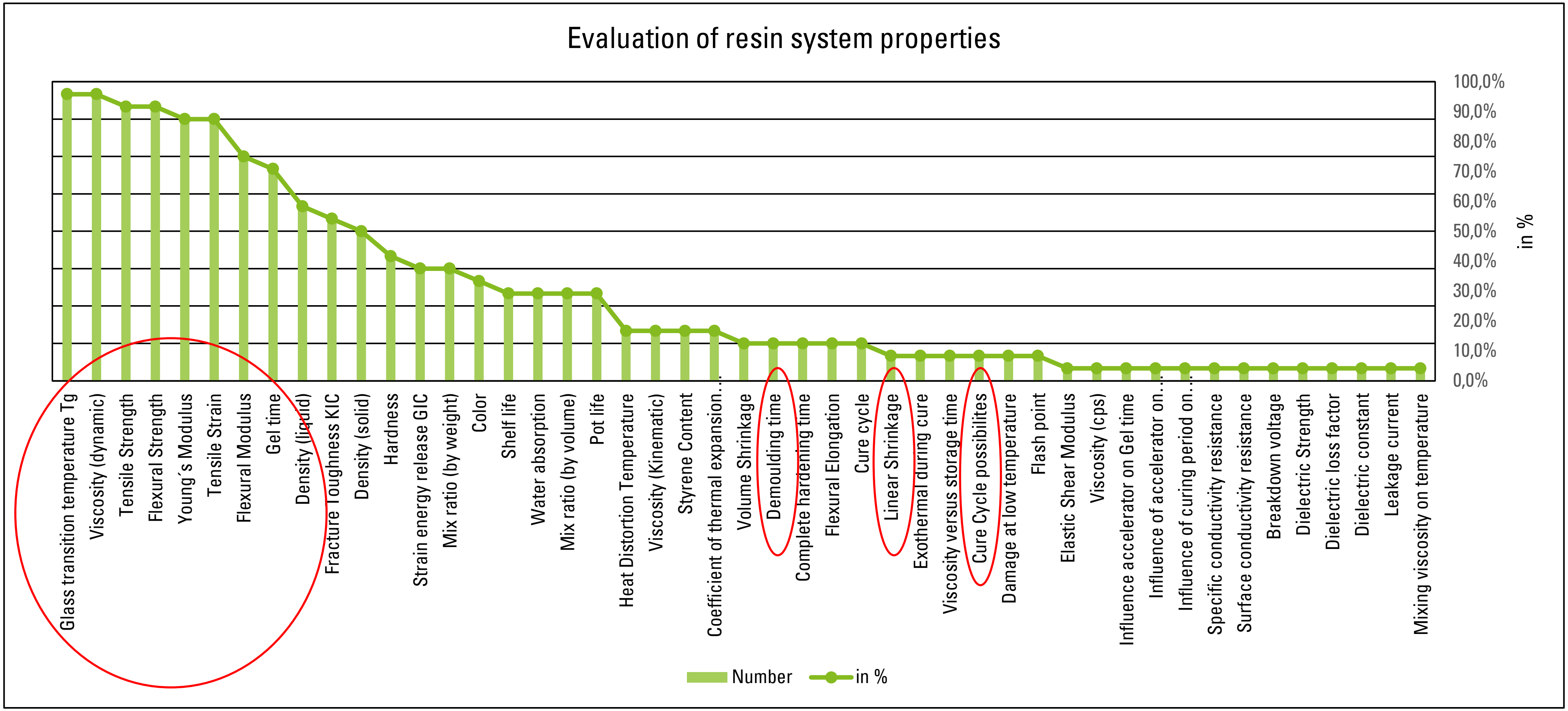
No.	Company	Product	Properties																																												
			Density (solid)	Density (liquid)	Flash point	Linear Shrinkage	Volume Shrinkage	Fracture Toughness K_{IC}	Strain energy release G_{IC}	Youngs´s Modulus	Tensile Strain	Tensile Strength	Elastic Shear Modulus	Hardness	Exothermal during cure	Flexural Strength	Flexural Modulus	Flexural Elongation	Heat Distortion Temperature	Coefficient of thermal expansion	Specific conductivity resistance	Surface conductivity resistance	Breakdown voltage	Dielectric Strength	Dielectric loss factor	Dielectric constant	Leakage current	Glass transition temperature T_g	Viscosity (dynamic)	Viscosity (Kinematic)	Viscosity (cps)	Styrene Content	Gel time	Pot life	Viscosity versus storage time	Shelf life	Damage at low temperature	Color	Mix ratio (by weight)	Mix ratio (by volume)	Demoulding time	Cure cycle	Complete hardening time	Influence accelerator on Gel time	Accelerator on temperature resistance	Curing period on temperature resistance	Mixing viscosity on temperature	Water absorption	Cure Cycle possibilities
1	3M	Matrix Resin 4831	X			X		X		X	X	X		X	X													X	X																				
2	3M	Matrix Resin 4832	X			X		X		X	X	X		X	X													X	X																				
3	Ashland	Derakane 411-350 Epoxy Vinyl Ester Resin	X	X			X			X	X	X		X		X	X		X									X	X	X		X	X																
4	Ashland	Derakane 441-400 Epoxy Vinyl Ester Resin	X	X			X			X	X	X		X		X	X		X									X	X	X		X	X																
5	Ashland	Derakane 510A-40 Epoxy Vinyl Ester Resin		X						X	X	X		X		X	X		X										X	X		X	X																
6	Ashland	Derakane Momentum 411-350 Epoxy Vinyl Ester Resin	X	X			X			X	X	X		X		X	X		X									X	X	X		X	X																
7	Axson	Epolam 2020		X								X		X		X	X											X	X				X	X				X	X	X	X		X	X	X	X			
8	Axson	Epolam 2035 + Epolam 2025 Hardener	X	X						X	X	X		X		X	X			X								X	X					X				X	X								X		
9	Axson	Epolam 8052		X						X	X	X				X	X											X	X				X					X	X	X								X	
10	Axson	Epolam 8064 Resin + Epolam 8045 Hardener + 5X Hardener (Accelerator)		X						X	X	X				X												X	X				X	X				X	X	X								X	
11	Bakelite	Bakelite EPR 04572														X	X	X			X	X	X	X	X	X	X	X	X					X		X			X										
12	Cytec	Cycom 823 RTM Resin System	X					X	X	X	X	X	X			X	X	X										X			X																		
13	Cytec	CYCOM 5250-4 RTM RESIN SYSTEM	X					X	X	X	X	X				X		X		X								X	X				X																
14	DSM	Daron 120						X	X	X	X	X				X	X											X	X				X																
15	DSM	Daron 150/B25						X	X	X	X	X				X	X											X	X				X																
16	DSM	Daron 200/B25						X	X	X	X	X				X	X											X	X				X																
17	Henkel	Loctite Max 2		X				X		X	X	X		X		X	X											X	X							X	X	X	X	X			X						
18	Henkel	Loctite Max 3		X				X		X	X	X		X		X	X											X	X							X	X	X	X	X			X						
19	Hexcel	HexFlow RTM 6 (global version)	X	X					X	X	X	X				X	X											X	X				X		X	X					X							X	X
20	Hexcel	HexFlow RTM 6-2	X	X					X	X	X	X				X	X											X	X				X		X	X					X							X	X
21	Hexcel	HexFlow RTM651 (EU Version)	X					X		X	X	X				X	X											X	X				X	X		X													
22	Hexcel	HexFlow VRM37	X					X								X	X											X	X				X			X						X						X	
23	Huntsman	Araldite LY 556; Aradur 917; Accelerator DY070		X	X			X	X	X	X	X				X				X								X	X				X	X				X	X	X		X						X	
24	Huntsman	Araldite LY 556; Aradur 22962		X	X			X	X	X	X	X				X				X								X	X				X	X				X	X	X		X						X	
		Total	12	14	2	2	3	13	9	21	21	22	1	10	2	22	18	3	4	4	1	1	1	1	1	1	1	23	23	4	1	4	17	7	2	7	2	8	9	7	3	3	3	1	1	1	1	7	2

- 24 material data sheets of 9 companies were investigated
- 47 different properties were found

Which properties are necessary to satisfy the needs of all participants?

Overview of Material Data Sheets
Current Data Sheet Analysis



- 24 material data sheets of 9 companies were investigated
- 47 different properties were found

Which properties are necessary to satisfy the needs of all participants?

Overview of Material Data Sheets

Comparison of exemplary Material Systems

			EP – Baxxodur	PU – Elastolit	PA - RIM
Process relevance	Components temperature	[°C]	80	**45**	100-120
	Mould temperature	[°C]	90-120	**80**	140-160
	Mix ratio		100 : 10-25	100 : 170	**100 : 100**
	Viscosity at injection temp.	[mPas]	70	50	**5**
	Time for demoulding	[min]	3-5	4-5	**2-3**
	Charge technology		LP / HP	LP / HP	LP / HP
Design relevance	Glass transition temp.(Tm)	[°C]	**145**	105	60 (220)
	Young's modulus	[Mpa]	2900	2400	**3400**
	Breaking elongation	[%]	5	6	**20**
	Fracture toughness (G_{Ic})	[J/m²]	240 J/m²	**430 J/m²**	-

Source: Basf11

Overview of Material Data Sheets

Inconsistency of Material Data Sheets

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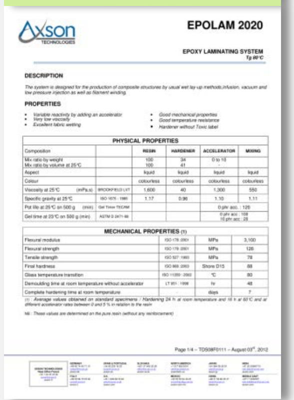
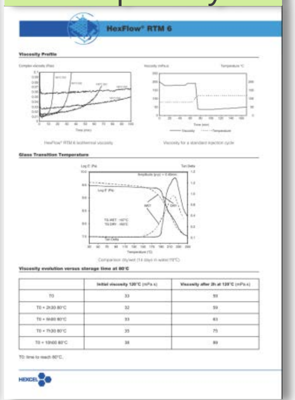
Different presentation of the same values

Tabular



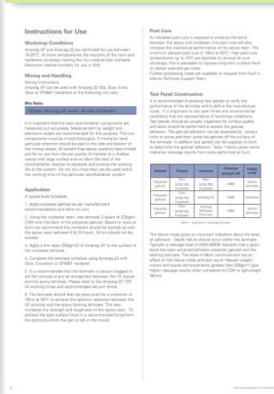
Source: Axson

Graphically



Source: Hexcel

Text



Source: Gurit

Inconsistency of mentioned properties

Source: Hexcel

→ Different **properties** are listed, even in data sheets of the same material group of one company

→ Different **terms** of same properties

→ Different **amount** of listed properties
(range in this study: 10 – 18)

Different structure and order in data sheets

Source: DSM

Source: Bakelite

- The most rational way of displaying data information is to be defined
- The **relevant properties** and testing methods are to be defined
- A structure that guarantees a good **overview and comparability** needs to be established

Overview of Material Data Sheets

Standards for Testing Matrix Systems

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Different standards are used to determine the same material property

e.g. ASTM (USA) vs. ISO (intern.) for the glass transition temperature T_g:

3M

Matrix Resin

4831

July 2011

Product Description

3M™ Matrix Resin 4831 is a high performance DGEBA (Bis-A) epoxy matrix resin for use in carbon fiber composites compatible with the filament winding manufacturing process. 3M™ Matrix Resin 4831 is recommended for use with anhydride curatives.

Typical Cured Neat Resin Properties

The following technical information and data should be considered representative or typical only and should not be used for specification purposes.

Property	Test Method	3M™ Matrix Resin 4831	Typical Epoxy
Density (g/cc)	ASTM D792	1.41	1.22
Linear Shrinkage (%) (cured 2 hours at 90°C, 2 hours at 150°C)	ASTM D2566	0.37	0.53
Mechanical Properties			
Fracture Toughness K_{Ic} (MPa- √m)	ASTM D5045 (Compact tension geometry)	1.32	0.52
Tensile Modulus (ksi) Max Strain to Break (%) Yield Stress (ksi)	ASTM D638	 722 6.6 12.8	 466 10.4 12.9
Barcol Hardness (H_B)	ASTM D2583	58	38
Thermal Properties			
Exotherm During Cure ΔH @ 10 ºC/min (J/g)	ASTM D3418	180	294
Glass Transition Temperature (ºC)	ASTM D3418-08	111	134
Viscosity			
Property	Test Method	3M™ Matrix Resin 4831	Typical Epoxy
Complex Viscosity η* (Pa·s) @ 30 ºC @ 40 ºC @ 50 ºC @ 60 ºC	Dynamic Mode, 1 Hz, parallel plate	 1.40 0.65 0.34 0.20	 0.63 0.29 0.14 0.09

ASTM D3418-08: DSC

(Differential Scanning Calorimetrie)

ISO 11359: TMA

(Thermomechanical Analysis)

Axson TECHNOLOGIES

EPOLAM 2020

EPOXY LAMINATING SYSTEM

Tg 80°C

DESCRIPTION

The system is designed for the production of composite structures by usual wet lay-up methods,infusion, vacuum and low pressure injection as well as filament winding.

PROPERTIES

- *Variable reactivity by adding an accelerator*
- *Very low viscosity*
- *Excellent fabric wetting*
- *Good mechanical properties*
- *Good temperature resistance*
- *Hardener without Toxic label*

PHYSICAL PROPERTIES					
Composition		RESIN	HARDENER	ACCELERATOR	MIXING
Mix ratio by weight Mix ratio by volume at 25°C		100 100	34 41	0 to 10 -	
Aspect		liquid	liquid	liquid	liquid
Colour		colourless	colourless	colourless	colourless
Viscosity at 25°C (mPa.s)	BROOKFIELD LVT	1,600	40	1,300	550
Specific gravity at 25°C	ISO 1675 : 1985	1.17	0.96	1.10	1.11
Pot life at 25°C on 500 g (min)	Gel Timer TECAM			0 phr acc. : 120	
Gel time at 23°C on 500 g (min)	ASTM D 2471-99			0 phr acc : 100 10 phr acc : 20	

MECHANICAL PROPERTIES (1)			
Flexural modulus	ISO 178 :2001	MPa	3,100
Flexural strength	ISO 178 :2001	MPa	126
Tensile strength	ISO 527 :1993	MPa	78
Final hardness	ISO 868 :2003	Shore D15	88
Glass temperature transition	ISO 11359 : 2002	°C	80
Demoulding time at room temperature without accelerator	LT 051 : 1998	hr	48
Complete hardening time at room temperature	-	days	7

Overview of Material Data Sheets
Standards for Testing Matrix Systems

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Currently used standards in the industry as an example:

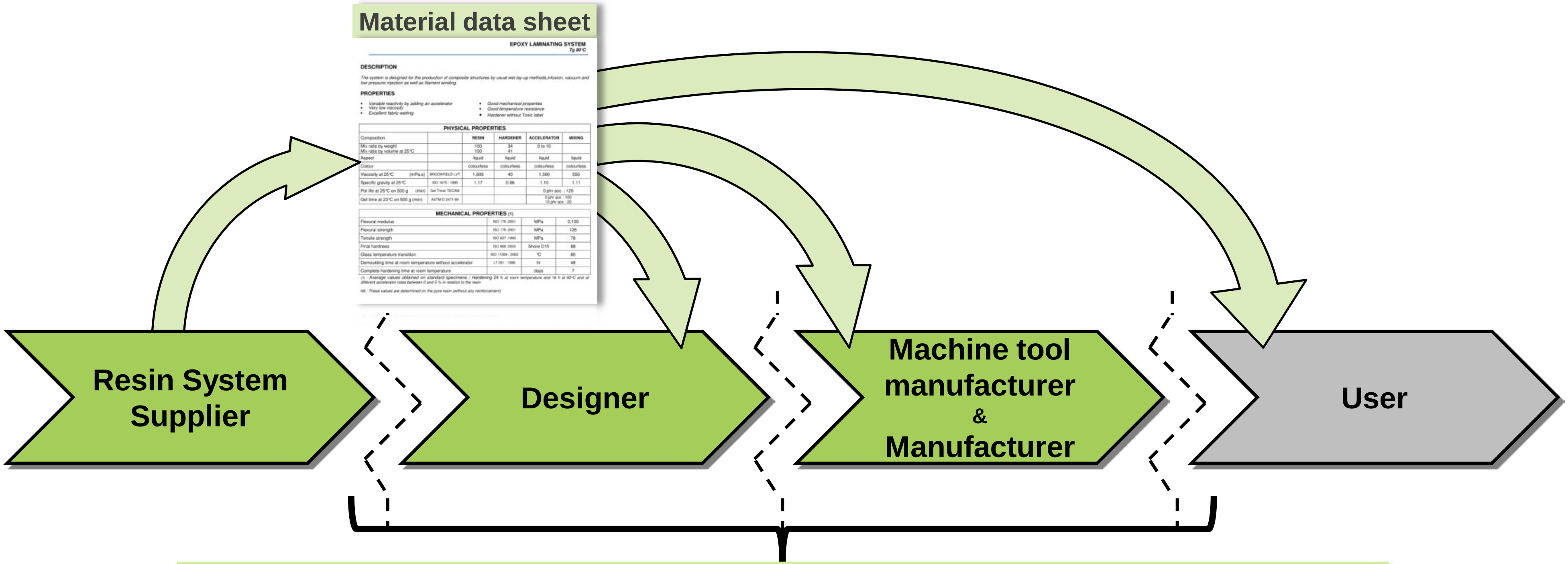
Material Property	Standards
Density	ASTM D792, ISO 1183, ISO 2781
Heat distortion temperature	ASTM D648, ISO 75
Hardness	ASTM D2583, EN59, ISO 868
Flexural rigidity	ASTM D790, ISO 178
Glass transition temperature	ASTM D3418-08, ASTM D3419, ISO 11359-2, ISO 11357
Gel time	ASTM D2471-99, ISO 8130-6

Variety of standards and test methods make a comparison of values and materials nontransparent

Content

Requirements for Simulation Purposes

Product and Process Design by Simulations



PAM-Form	Abaqus	ESAComp
PAM-RTM	NEi Nastran	Ansys Composites Prepost
LIMS	Helius:MCT	RAVEN
LCMFlot	Compositor/ALAN	COMPRO
RTMWorx	LS-Dyna	PAM-Crash, …

Requirements for Simulation Purposes
Exemplary Composite Simulations

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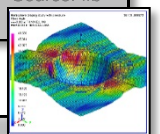
PAM-Form

Source: ifb



e.g. Ogden model

➢ Hyperelastic material model which describes the non-linear stress-strain behaviour of complex materials

PAM-RTM

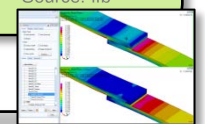
Source: compositesuk

e.g. Darcy's law

➢ Phenomenologically derived constitutive equation that describes the flow of a fluid through a porous medium

LS-Dyna

Source: ifb

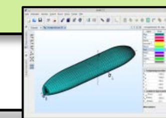


e.g. Gurson model

➢ Based on the concept that during plastic deformation, micro voids nucleate and grow until a local plastic neck or fracture of the inter voids matrix occurs

COMPOSITOR/ ALAN

Source: TUD



e.g. Puck's theory

➢ Three-dimensional failure hypothesis for UD FRPC's which is stress-based

Requirements for Simulation Purposes
Composite Simulation

Each simulation software uses different input values:

Input Values
(Examplary except)

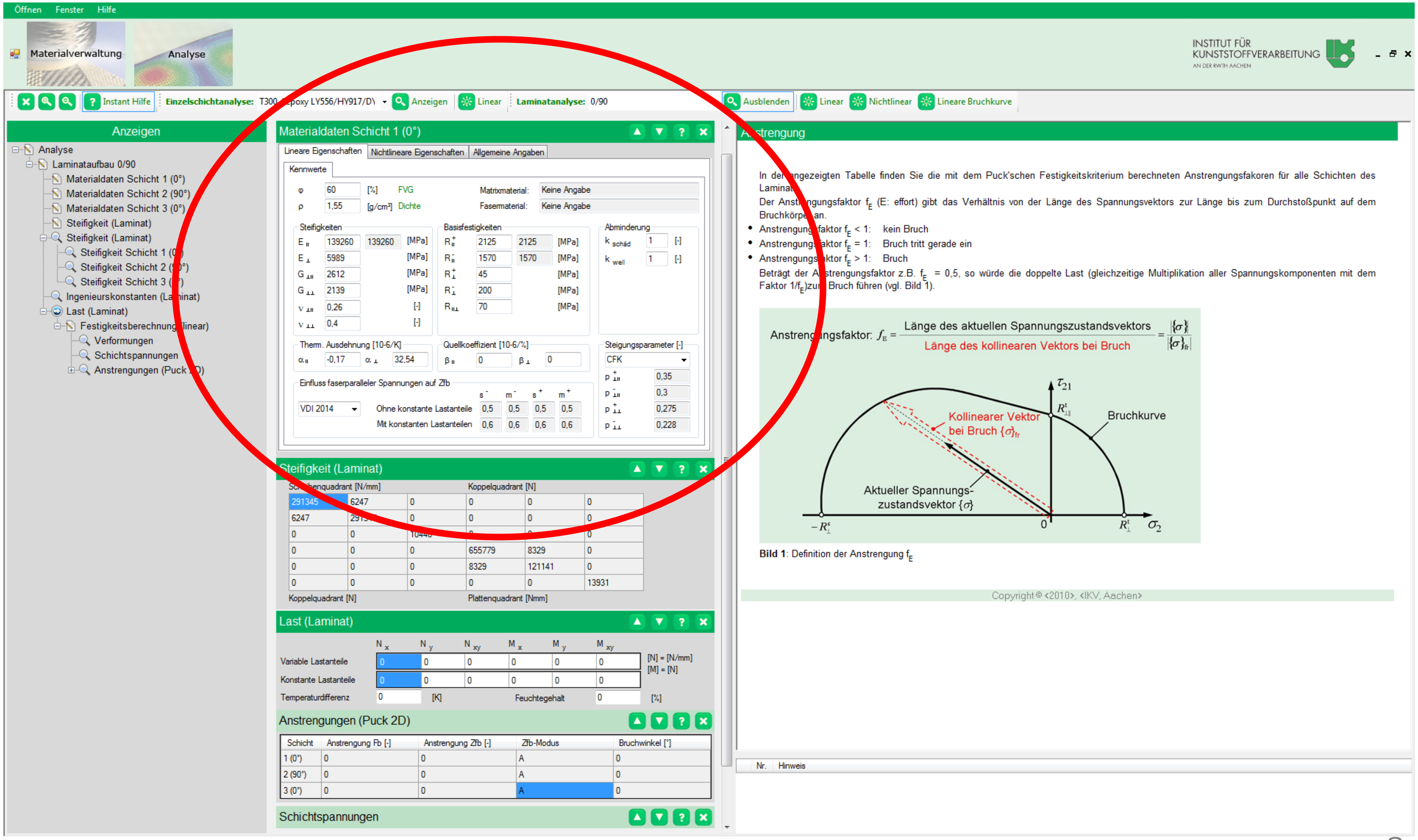
PAM-Form	PAM-RTM	LS-Dyna	ALAN	…
Density	Vacuum pressure	Strain energy release rate	Density	…
Bending stiffness	Fiber permeability	Stress intensity factor	Elastic modulus	…
Fiber modulus	Nominal weight	Poisson's ratio	Shear modulus	…
Resin viscosity	Inj. temperature	Strength	Poisson's ratio	…
Geometric data (e.g. fiber orient.)	Resin viscosity	Crack energys	Geometric data	…

Further input data:

- boundary conditions
- number of plies in the laminate
- stacking sequence

Not every input value is generally listed on the data sheets for a composite simulation

Requirements for Simulation Purposes
Exemplary Simulation Input – ALAN



Source: IKV

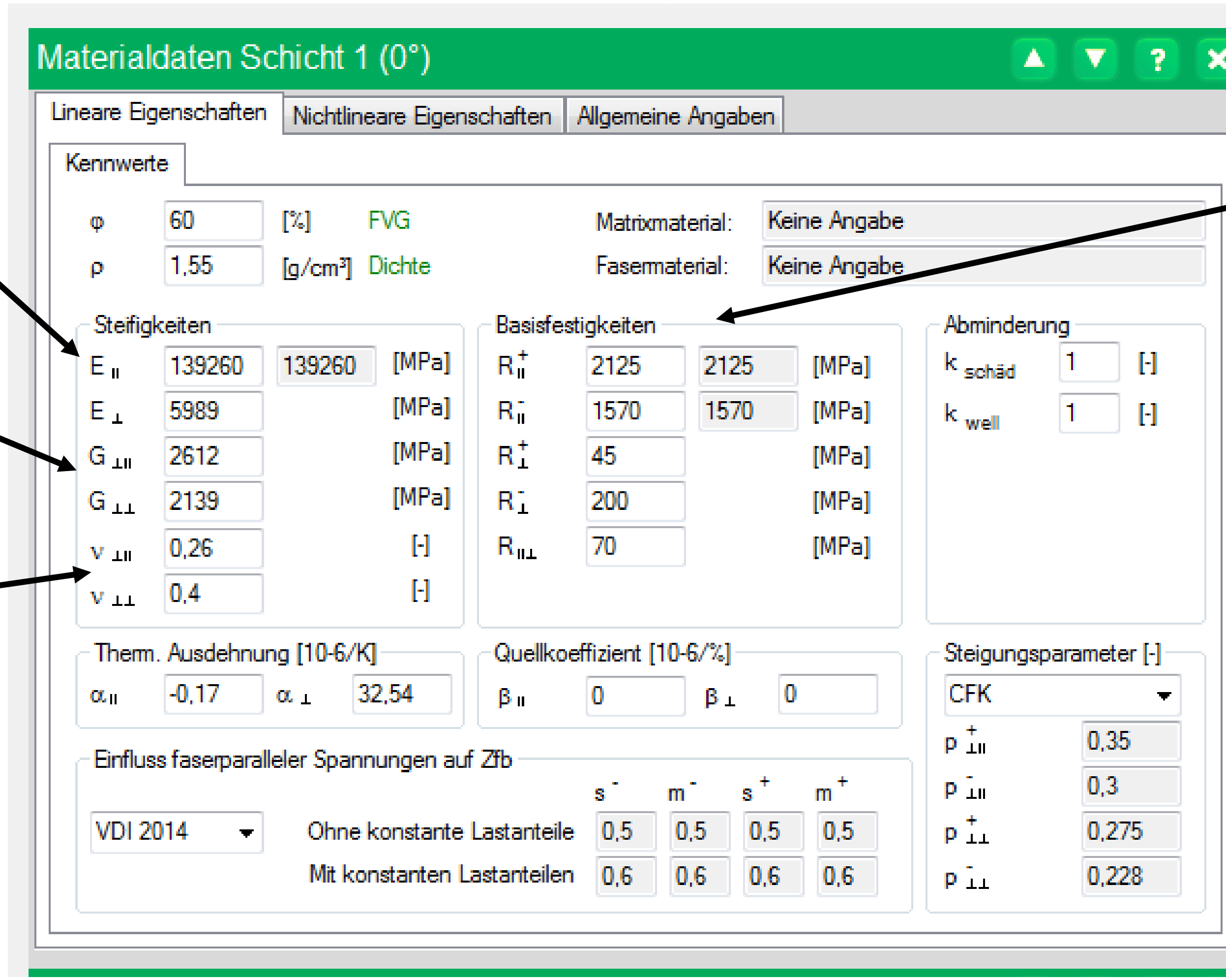
Requirements for Simulation Purposes

Exemplary Simulation Input – ALAN

Elastic modulus

Shear modulus

Poisson ratio



5 basis strengths of a UD-layer have to be measured

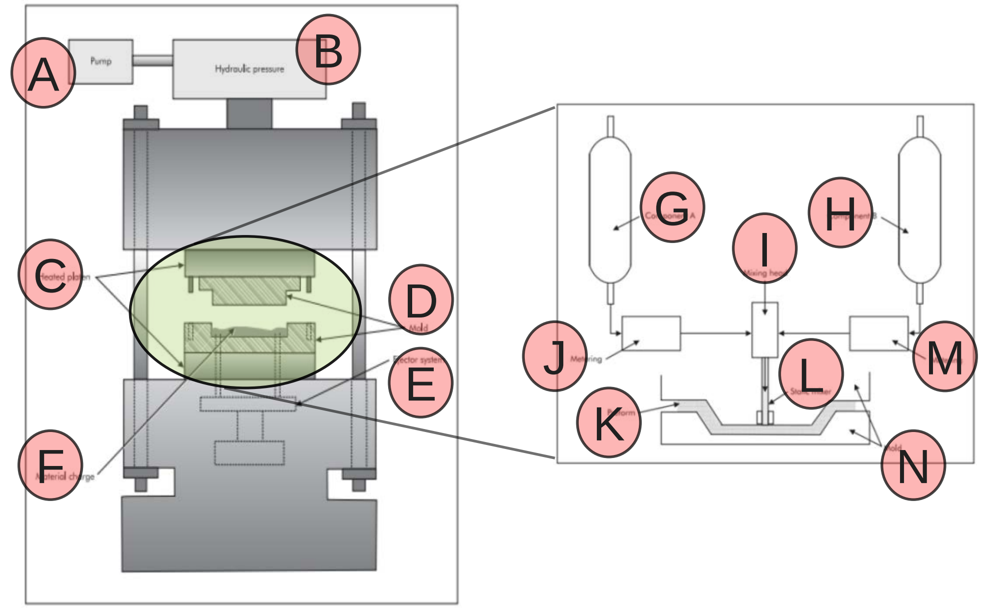
(Orientated strengths by Puck)

Source: IKV

Content

Machinery and Process Requirements for RTM
RTM Machine Components

Source: KraussMaffei



Source: LTU

In the machine design process each machine component is influenced by material properties (viscosity, chemical,…)

A - Pump
B - Hydraulic pressure
C - Heated platen
D - Mold
E - Ejector system
F - Material charge
G - Component A
H - Component B
I - Mixing head
J - Metering
K - Preform
L - Static mixer
M - Metering
N - Mold

Challenges of RTM Components

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Mold concept

Mixing and injection unit

Press and drive system

Direct impact

- **Chemical compatibilities**
- **Sealing system/ concept**
  - Materials and chemical compatibility (e.g. HNBR, EPDM, FFPM, PTFE)
  - Concept, e.g. o-ring, labyrinth seal bellow-type seal, shearing edges…
- **Cleaning of the cavity** (form release agent, surface treatment, coating)
- **Gate system and vacuum process** Pressure characteristics, Gating, flow gate, air vent, resin trap, flow path and front

Indirect impact

- Design and dimensioning of the mold
- Part ejection, demolding
- Heating technology, rates
- Specific sensor technology

Machinery and Process Requirements for RTM

Challenges of RTM Components

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Mold concept

Mixing and injection unit

Press and drive system

Direct impact

- **Mass flow rate and injection pressure** characteristics
- **Material compatibilities**
- **Cleaning and scavenging system** (by the use of different materials, the previous substances have to be removed completely)

Indirect impact

- Dimensioning and material selection of the unit components
- Maintenance (sealing, slide feed)

Challenges of RTM Components

Mold concept

Mixing and injection unit

Press and drive system

Direct impact

- Drive power, **motion speed and acceleration**, (e.g. pressure buildup times, speed profiles , accumulator drive)

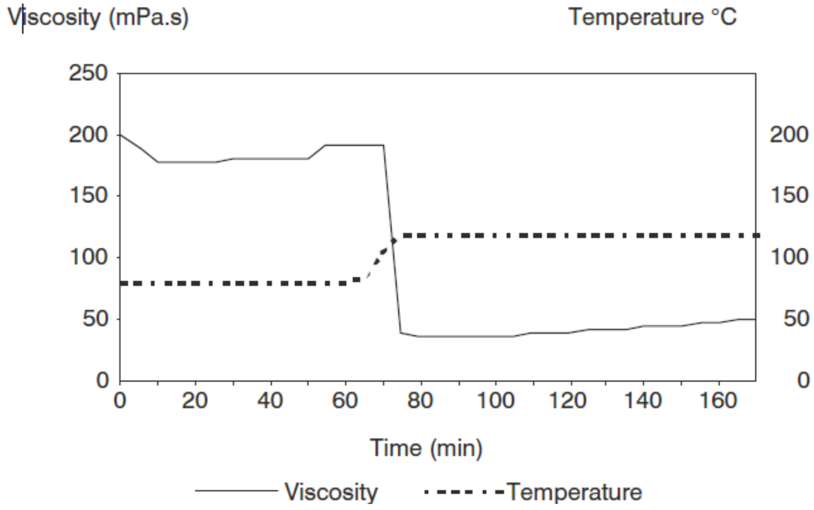
Indirect impact

- Accuracy: Parallel motion and aligning the mold (e.g. optimized deflection properties)
- Sensor technology
  (controlled speed profiles, active ram parallelism control)

- Electro-mechanical press
  (e.g. screw press)
- Hydraulic press
  (e.g. short-stroke presses)

Exemplary Process Information of a Data Sheet

Viscosity for a Standard Injection Cycle



Viscosity Build-Up [ISO 12058-1]

		System A	System B
T [°C]	[mPa.s]	t* [h]	t* [h]
25	To 1500	10-12	3.5-4.5
40	To 1500	19-21	7-8

Gel Time [Hot Plate]

T [°C]	t [min]
120	54
140	30
180	12

Initial Mix Viscosity [Falling Sphere Viscometer]

	[mPa.s]	T [°C]
Resin	10000-12000	25
Hardener	50-100	25
Accelerator	≤50	25

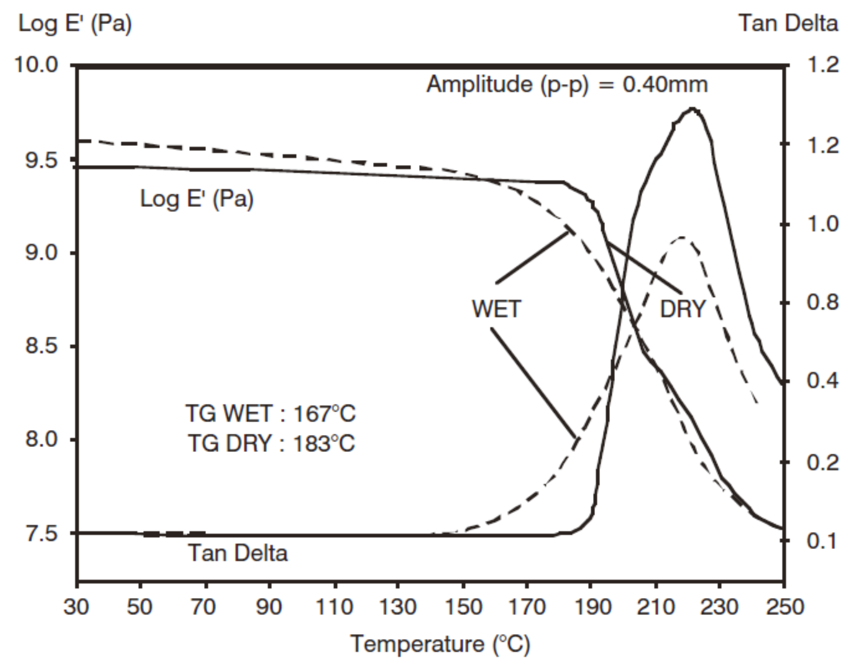
Source: Hexcel, Huntsman

Exemplary Process Information of a Data Sheet

Glass Transition Temperature [IEC 1006; 10 K/min]

Cure	T_G - DSC [°C]	T_G - TMA [°C]
4h 80°C + 4h 120°C	140-144	125-128
4h 80°C + 8h 120°C	144-148	125-128
4h 80°C + 4h 140°C	145-150	130-135
4h 80°C + 8h 140°C	148-153	135-145
4h 80°C + 4h 160°C	150-155	140-145
4h 80°C + 8h 160°C	150-155	140-145

Glass Transition Temperature [ISO 6731-4]



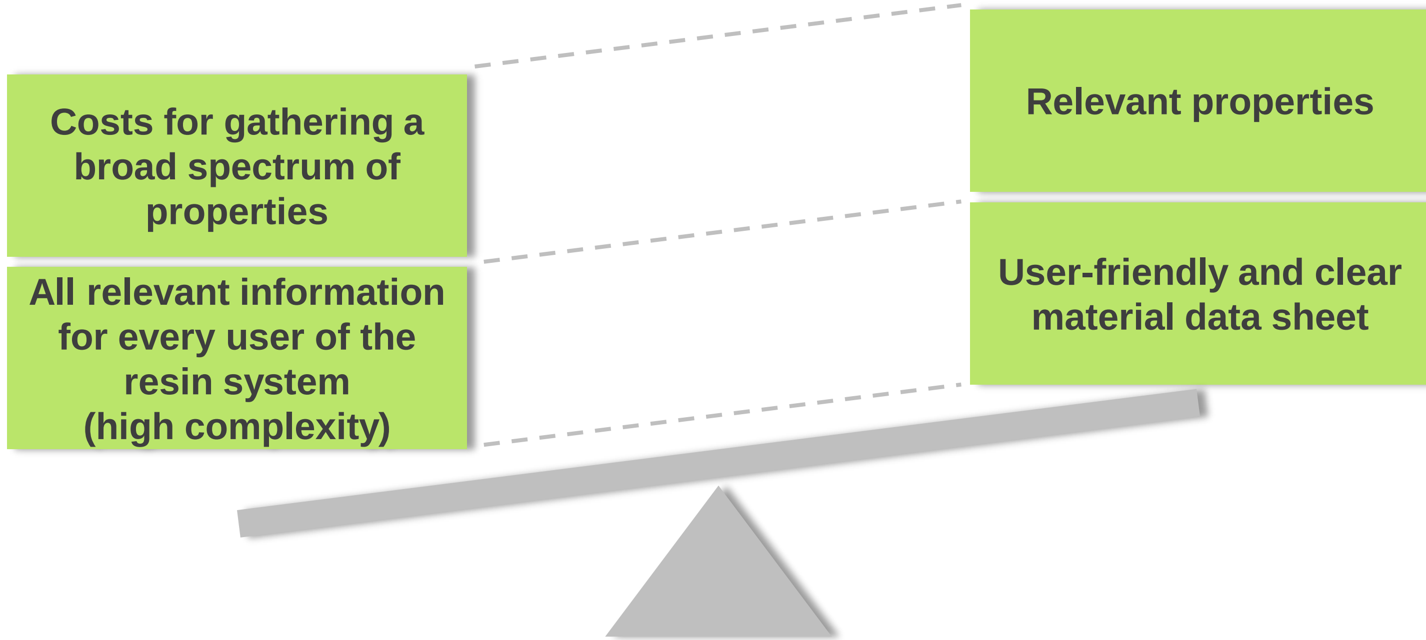
Comparison dry/wet (14 days in water/70°C)

Source: Hexcel, Huntsman

Material Data Sheet Study

Content

Challenges of Material Date Sheets



- Find the balance between an all-information containing material data sheet and an easy-to-use concept
  - → Define material data sheets for the user (product designer, machine tool manufacturer,…)
- Cost for gathering data are high. Which data is really relevant for the user?
  - → Analyze/ define the relevant properties including the most appropriate testing method

Conclusion and Discussion

Draft of Standard Material Data Sheet

Aachener Zentrum für integrativen Leichtbau

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RTM Standard Data Sheet

Description

HexFlow® RTM 6 is a a monocomponent resin already degassed, specifically developed to fulfil the requirements of the aerospace and space industries in advanced resin transfer molding(RTM) process.

Applications

- Automotive
- Aeronautical Industry

Properties

A1.1 Components Properties [x1 by component]

Aspect

Viscosity at 25°C [ISO- 12058-1]

Density at 25°C [ISO 1675]

A1.2 Resin Properties

Mix Ratio

	Parts By Weight	Parts by volume
Resign	75	132
Hardener	2890	3300
Accelerator	0,5-2	0,5-2

Poisson´s Ratio	1,11
Uncured Resin Density [g/cm³] at 25°C (ISO 1183)	1,14
Cured Resin Density [g/cm³] at 25°C (ISO 1183)	0,3
K_{1C} Fracture Toughness Bend Notch Test (ISO 13586) [MPa√m]	168
G_{1C} Fracture Energy Bend Notch Test (ISO 13586 [J/m²]	

	Tensile	Flexure
Strength [MPa]	75	132
Modulus [MPa]	2890	3300
Strain (%)	3,4	
Standard Specifications[ISO]	ASTM D638	ASTM D790

Description

General description of resin-system in text form to specify the unique selling points of the product and typical applications of the product

Properties (tabular)

Component/System properties:
- Viscosity at RT and processing temperature
- Density at RT
- Color

Properties of the resin-system:
- Mixing ratio (in parts-by-weight and parts-by-volume)
- Density of uncured and cured resin-system
- Fracture toughness and fracture energy (bend notch test)
- Strength (tensile and flexure)
- Modulus (tensile and flexure)
- Failure strain (tensile)
- Barcol hardness
- Color

Conclusion and Discussion

Draft of Standard Material Data Sheet

RTM Standard Data Sheet

A2. Processing Information

Machine

Mould Temperature [°C]

Injection Pressure [Pa]

Curing Information [time], [°T] and [Δ°T]

Resin-System

Initial Mix Viscosity (Cone-Plate Viscometer)

T [°C]	[mPa.s]
25	900-1100
40	200-300
60	70-80

Viscosity Build-Up (ISO 12058-1)

T [°C]	[mPa.s]	T [s]
Resign	75	132
Hardener	2890	3300
Accelerator	0,5-2	0,5-2

Glass Transition Temperature

Storage

Shelf Life [23°C] 15 day maximum

Guaranteed Shelf Life [-18°C] 9 months

Gel Time [Hot Plate]

T [°C]	t [min]
120	54
140	30
180	12

Properties (tabular)

Product properties **concerning the machine** side setting of the resin system:

- Mould temperature
- Injection pressure
- Curing information

Processing information of the resin-system:

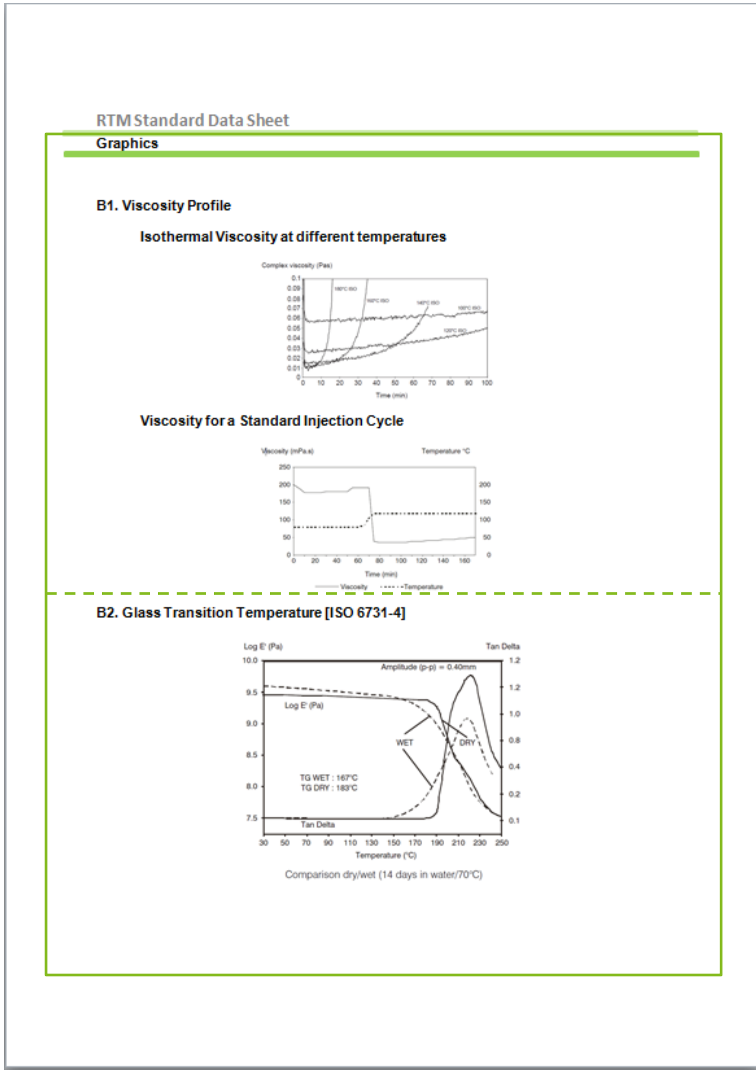
- Initial viscosity of resin system depending on temperature
- Viscosity build-up of the resin-system depending on temperature
- Glass transition temperature T_g

Storage and usability of resin system:

- Shelf life at RT
- Guaranteed shelf life with special storage conditions
- Gel time

Conclusion and Discussion

Draft of Standard Material Data Sheet


RTM Standard Data Sheet

Graphics

B1. Viscosity Profile

Isothermal Viscosity at different temperatures

Viscosity for a Standard Injection Cycle

B2. Glass Transition Temperature [ISO 6731-4]

Properties (graphically)

Viscosity development for various parameters:

- Time vs. viscosity (isothermal)
- Time vs. viscosity (typical injection cycle)
- …

Glass transition temperature depending on various parameters

Water pick-up (time vs. percent)

… various further possibilities.
Which are needed additionally?

Conclusion and Discussion
Standard Laminates

Mechanical Properties of a standard textile can increase comparability of different suppliers

Examples in data sheets

Ashland
glass fiber

Laminate:
- Continuous veil glass
- Chopped strand mat 450 g/m²
- Chopped strand mat 450 g/m²
- Wowen roving 800 g/m²
- Chopped strand mat 450 g/m²
- Wowen roving 800 g/m²
- Chopped strand mat 450 g/m²

curing cycle mentioned

DSM
carbon fiber

2mm 4 UD-layers NCF:
- Saertex®
- Toray T700 C50 438 g/m²
- Saertex®
- Toray T700 C50 438 g/m²
- Saertex®
- Toray T700 C50 438 g/m²
- Saertex®
- Toray T700 C50 438 g/m²

curing cycle mentioned

Henkel
glass fiber

4 UD-layers NCF:
- Glass fiber 800 g/m²
- Glass fiber 800 g/m²
- Glass fiber 800 g/m²
- Glass fiber 800 g/m²

fiber content: 48 Vol. %

curing cycle mentioned

…

Definition of a standard laminate

Textile
- Fiber type (glass, carbon,…)
- Connection type (UD, weave,…)
- Roving (tex, K)
- Mass per unit area

System
- Resin-system
- Fiber volume content
- Laminate structure (UD, biax., multiax., …)
- Process conduction

Conclusion and Discussion
Standard Product Groups

In comparison to steel parts, composite parts have a nearly infinite amount of property variations. This is a great advantage of composite parts, but also hinders the adoption of those in mass production.

→ Define standard composite parts by further application of the parts:

Application	Impact	Strength driven	Stiffness driven	Appearance
Textile architecture	UD	Multi-axial NCF	Twill weave	Non-woven
Fiber type	Aramid	Glass	Carbon	Carbon/Glass
Resin system	…	…	…	…
⋮	⋮	⋮	⋮	⋮

- Is the idea of developing standard composite material systems of interest to both the production industry and supplier community? If not what should we be doing?
- Is this something that industry should do on their own and is there a role for the government in this process? Who should do this?
- Do we need target material applications/classes and how do we go about setting the targets for those?

Conclusion and Discussion

Other Activities – Standardization

Det Norske Veritas, Norway:

> structurally in a reliable and economical way.
> For this reason DNV started a JIP to develop a general standard for the design of load carrying structures and components fabricated from fibre-reinforced plastics and sandwich structures.
> Upon termination of the JIP, the members participating i.e. ...

- Realization of even simple designs of FRP structures tends to become a major undertaking due to the lack of applicable desing standards
- The **lack of a FRP guidline** is one of the major obstacles to utilize FRP structurally in a reliable and economical way
- Members of the JIP: ABB Offshore Technology, Ahlstrom Glassfibre, AMOCO, Akzo Nobel Faser AG, Baltek, MMS, Norsk Hydro etc.

National Composites Network, UK:

> technical textile companies to become expert in fields other than textiles so that they can provide textile 'solutions' to their customers' problems. A significant obstacle to exporting is the lack of common standards. Differences in national standards make it difficult to compete with local producers and effectively exclude them from government contract work. Research and ...

- Obstacle to exporting due to **lack of common standards**
- Diffcult competition conditions caused by **differences in national standards**

Ixpos, Germany:

> subsequent introduction of the Global Organic Textile Standard scheme (GOTS) in 2006 are the results of such an initiative. The main goal of the IWG is to continuously harmonize the different existing quality standards in order to achieve a uniform standard for organic textiles worldwide. The German International Association of the Natural Textile Industry (IVN) is ...

- The International Working Group (IWG) on Global Organic Textile Standard was found in 2002
- The IWG introduced a Global Organic Textile Standard Scheme (GOTS) in 2006
- IWG shows us that it is possible to find solutions in the textile industry on an international scale

Thanks for your attention.

Aachener Zentrum für integrativen Leichtbau

RWTH AACHEN UNIVERSITY

Material Data Sheet Study

Standardization for RTM Data Sheets

07/11/2014, Aachen

Dipl.-Ing. Stefan Schmitt