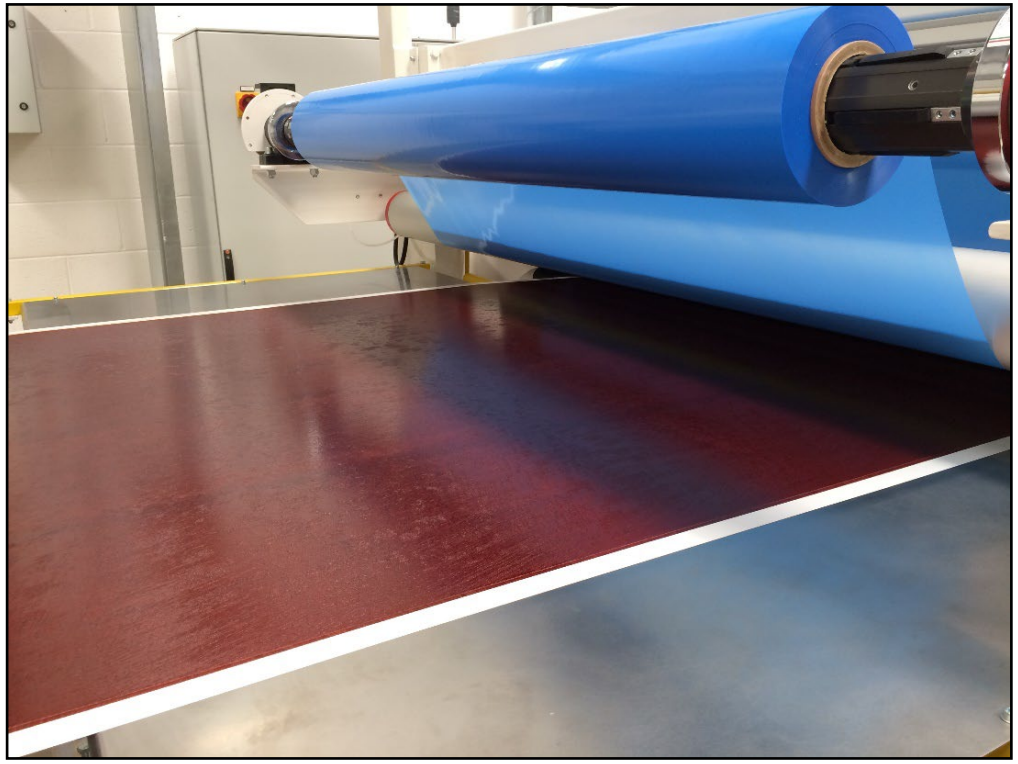
APP3 – Composite Prepreg

Translator Partner:

Fraunhofer IFAM

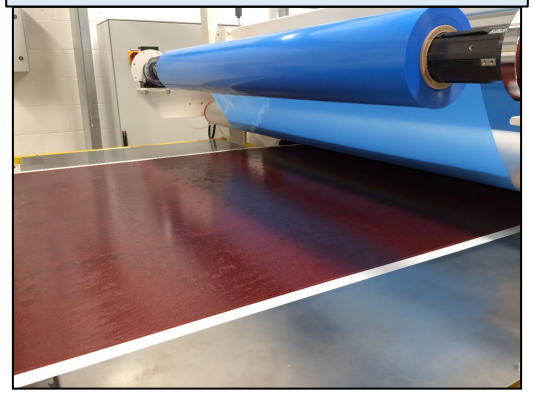
End User Partner:

Composites Evolution



Business Case

APP4 Composite Prepreg (CompEvo)



In terms of the business case, the following factors were highlighted as the most important:

- Market, regulatory and safety requirements drive the transition towards non-toxic, low environmental impact solutions for composite prepregs (fabrics pre-impregnated with resin)
- Innovative prepregs provide a potential solution
- PFA: fire retardant, eco friendly alternative to phenolic resins

1) Good understanding of the business case	**2) Good understanding of the industrial case**	**3) Analysis of the experimental (and modelling) data available within the client**	**4) Translation to (preferably more than one) workflow(s)**	**5) Propose to the client modelling executor(s) and strategy for model validation**	**6) Translation of the modelling results to information that is understandable and usable by the client**

Business Case

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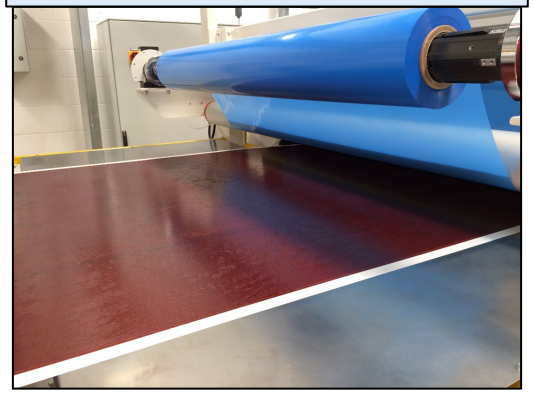

Aims of the innovation challenge:

- Improve understanding and control of process
- Improve quality of end products
- Reduce development time and costs
- Create model-based approach for future product developments

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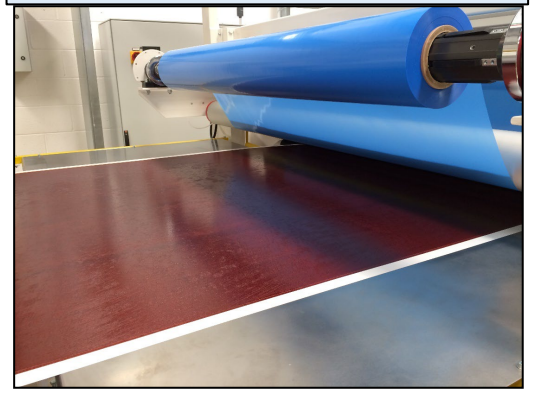
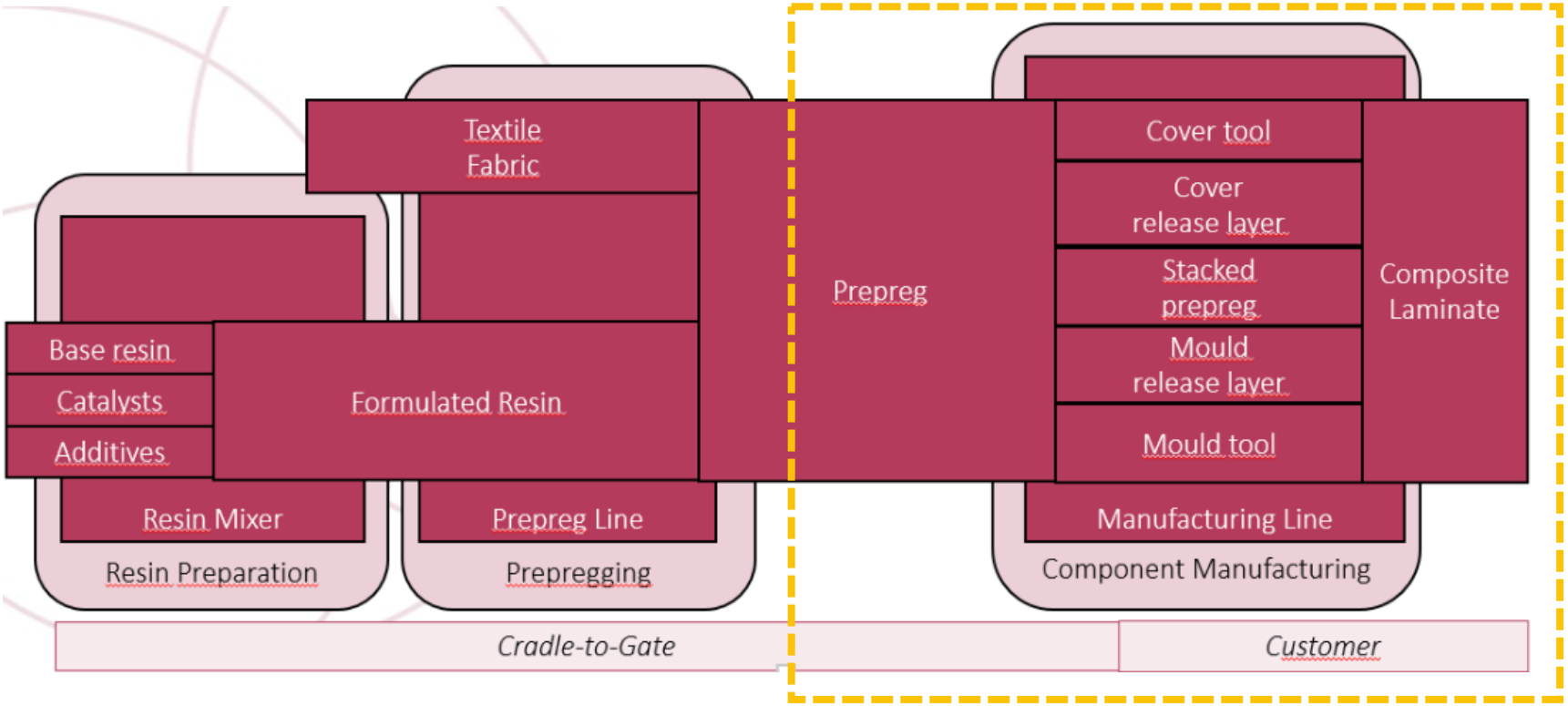
Industrial Case

APP4 Composite Prepreg (CompEvo)





translator acting as a „surrogate“ customer

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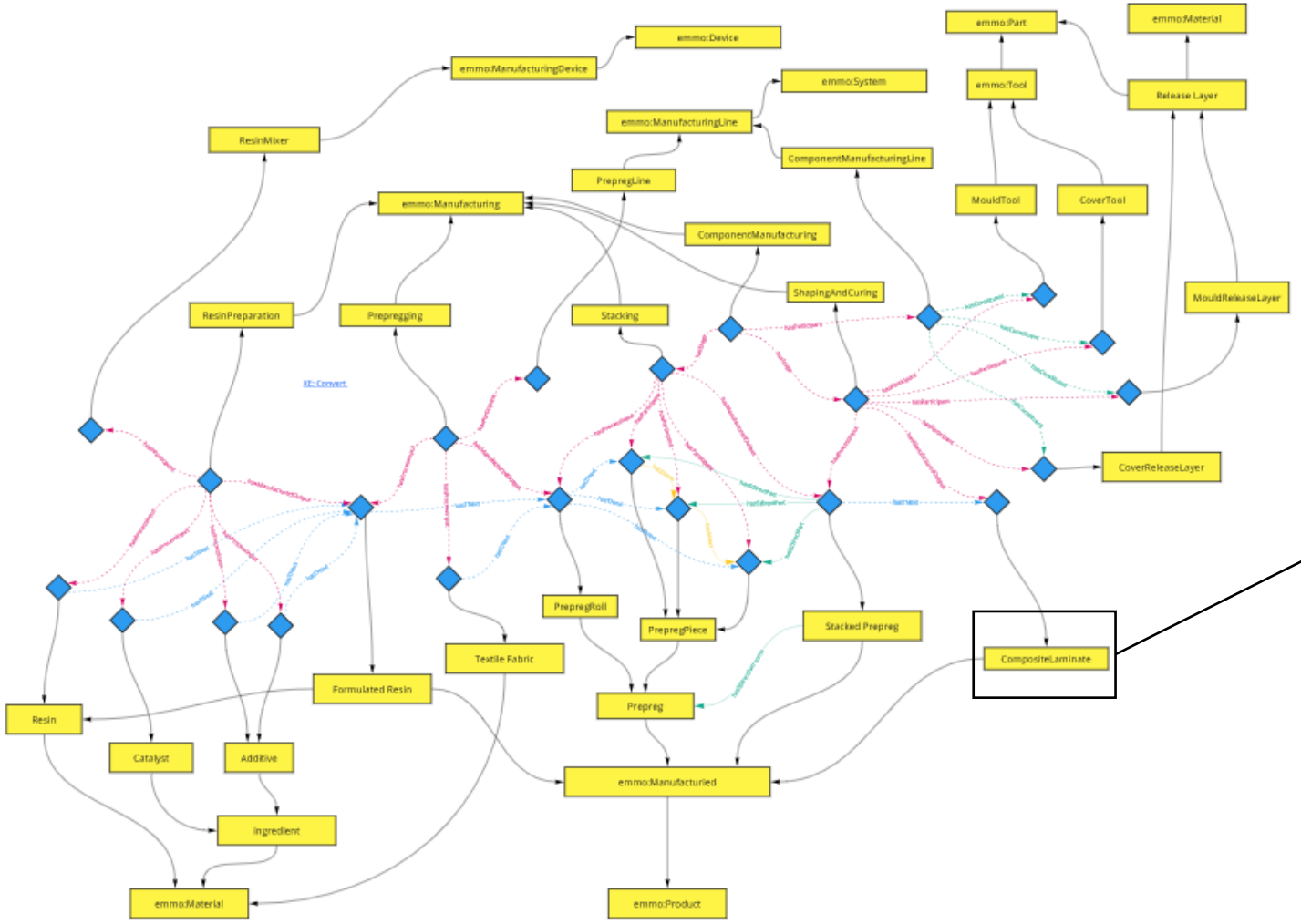
EMMO Compliant Application Ontology



Full EMMO description of industrial process

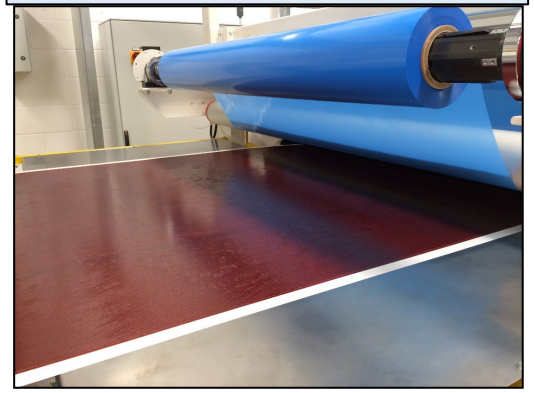
..including properties

Composite Laminate

Property Names	Property Description (semantics)	Data Description (symbolic)				Possible Interpreters				Source Data File Format
		Data Type	Data Range	Units	Reference Physical Quantity	Measured by	Modelled by	Assigned by	Other	
Composite Laminate Visual Surface finish	Using a (set of) specimen illumination settings, the appearance is compared with the appearance of a specified set of (reference) specimens	Set of strings	string (grade, string like "satisfactorily low", "unexpectedly high")	classification (high, low density of defects)	n.a	o.s.	o.s.	CompEvo, Client (of CompEvo)		User input (GUI)
Composite Laminate Surface-region porosity (quantitative)	Based on a light microscopy image of the smoother surface (i.e. the one visible to a user) of the composite laminate, the apparent surface area fraction occupied by pores is evaluated.	real scalar	]0,1[	(Surface) Area % (unitless)	contrast (in an image)	CompEvo, IFAM, Client (of CompEvo)	IFAM (measured and evaluated data are input for data-based model, i.e. Workflow 2B, DD-PMPA-M)	n.a.		.csv from image assessment OTE
Composite Laminate Bulk porosity (quantitative)	After performing a cross-cut perpendicular to the specimen surface, based on a light microscopy image, the apparent surface area fraction occupied by pores is evaluated	real scalar	]0,1[	(Surface) Area % (unitless)	area ratio	IFAM	IFAM (Workflow 1A M2C-PA-M; Workflow 2B DD-PMPA-M)	n.a		.csv from image assessment from the OTE
Porosity inferred from density	After cutting a test sample out of the specimen to be tested, gravimetric and volumetric findings are used to calculate an (average density that is compared to the density of a quantified reference("in order (i.e.)" specimen	real scalar	]0,1[	kg.m-3 /kg.m-3	mass ratio	IFAM	IFAM (Workflow 1A M2C-PA-M; Workflow 2B DD-PMPA-M)	n.a		User input (GUI) based on gravimetric assessment
Tensile strength	Maximum value of the stress-strain curve under tensile stress	Real scalar	]0, inf[	MPa (kg.m-1s-2)	stress resp. pressure (force per area at a maximum bearable loading)	CompEvo	IFAM (Workflow 1A M2C-PA-M; Workflow 2B DD-PMPA-M)	n.a.		.csv (respectively: gained from Adobe .pdf)
Tensile modulus	Tangent of the stress-strain curve under tensile stress	Real scalar	]0,inf[	MPa (kg.m-1s-2)	mechanical stiffness	CompEvo, IFAM	IFAM (Workflow 1A M2C-PA-M; Workflow 2B DD-PMPA-M)	n.a		.csv (respectively: gained from Adobe .pdf)
Flexural strength	Maximum value of the stress-strain curve under flexural stress	Real scalar	]0,inf[	MPa (kg.m-1s-2)	mechanical stress	o.s	IFAM (Workflow 1A M2C-PA-M; Workflow 2B DD-PMPA-M)	CompEvo Product Data Sheet		.csv (respectively: gained from Adobe .pdf)
Flexual modulus	Tangent of the stress-strain curve under flexural stress	Real scalar	]0,inf[	MPa (kg.m-1s-2)	mechanical stiffness	o.s	IFAM (Workflow 1A M2C-PA-M; Workflow 2B DD-PMPA-M)	CompEvo Product Data Sheet		.csv (respectively: gained from Adobe .pdf)
Elongation at break	ratio between increased length and initial length after breakage	Real scalar	]0,inf[	% (unitless)	length ratio	CompEvo, IFAM	IFAM (Workflow 1A M2C-PA-M; Workflow 2B DD-PMPA-M)	n.a		.csv (respectively: gained from Adobe .pdf)
Storage modulus	The storage modulus in viscoelastic materials measure the stored energy representing the elastic portion	Real scalar	]0,inf[	MPa	mechanical stress	CompEvo, IFAM	IFAM (Workflow 1A M2C-PA-M; Workflow 2B DD-PMPA-M)	n.a		.csv (respectively: gained from Adobe .pdf)
interlaminar shear strength	Mechanical property associated with the matrix-fibre interaction	Real scalar	]0,inf[	MPa	mechanical stress	CompEvo, IFAM	IFAM (Workflow 1A M2C-PA-M; Workflow 2B DD-PMPA-M)	n.a		.csv (respectively: gained from Adobe .pdf)
Glass transition temperature	Temperature for transition from glassy state into a viscous one	Real scalar	]0,inf[	°C	temperature	CompEvo, IFAM	IFAM (Workflow 1A M2C-PA-M; Workflow 2B DD-PMPA-M)	n.a		User input (GUI) from from DSC or DMA measurement
Fibre volume content	Ratio between the volume of fibre and the volume of the composite laminate	Real scalar	]0,1[	%	volume ratio	CompEvo, IFAM	IFAM (Workflow 1A M2C-PA-M; Workflow 2B DD-PMPA-M)	n.a		User input (GUI) from image assessment/density inferred

Innovation Challenge

APP4 Composite Prepreg (CompEvo)



APP4 interface designed to take into account both following problems:

Case 1:

- Input: new process parameters (temperature, pressure, geometry)
- Output: expected mechanical properties

Case 2

- Input: required mechanical properties
- Output: suitable process parameters

KPIs (measurable)

- Time-to-market (months)
- Number of tries (#)
- Mechanical performance
  - Interlaminar shear strength (MPa)
  - Tensile strength (MPa)

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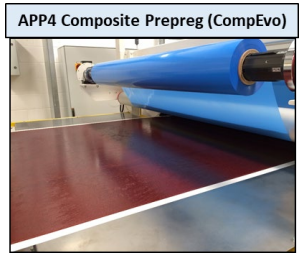

Data and Metadata Curation

Clients' Proprietary Data

- Internal measurements
  - Viscosity
- Resin formulation
- Tools geometry
- Manufacturing price

Clients' Publicly Available Data

- Product data sheet
  - Mechanical properties
  - Fibre content
  - Density
- Product sell price

Additional Data

- Benchmark values
- Reference values of mechanical properties
  - Tensile strength
  - Interlaminar shear strength

Data, data format, metadata

1) Good understanding of the business case

2) Good understanding of the industrial case

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Process Model

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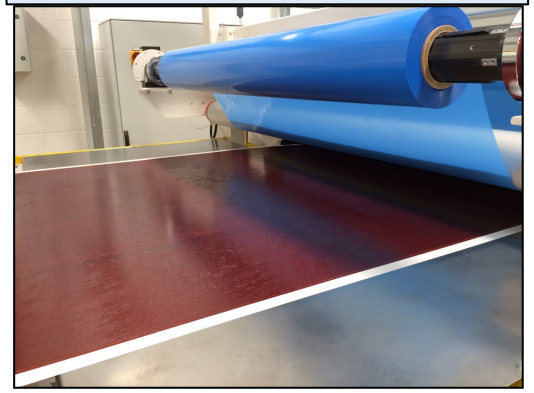

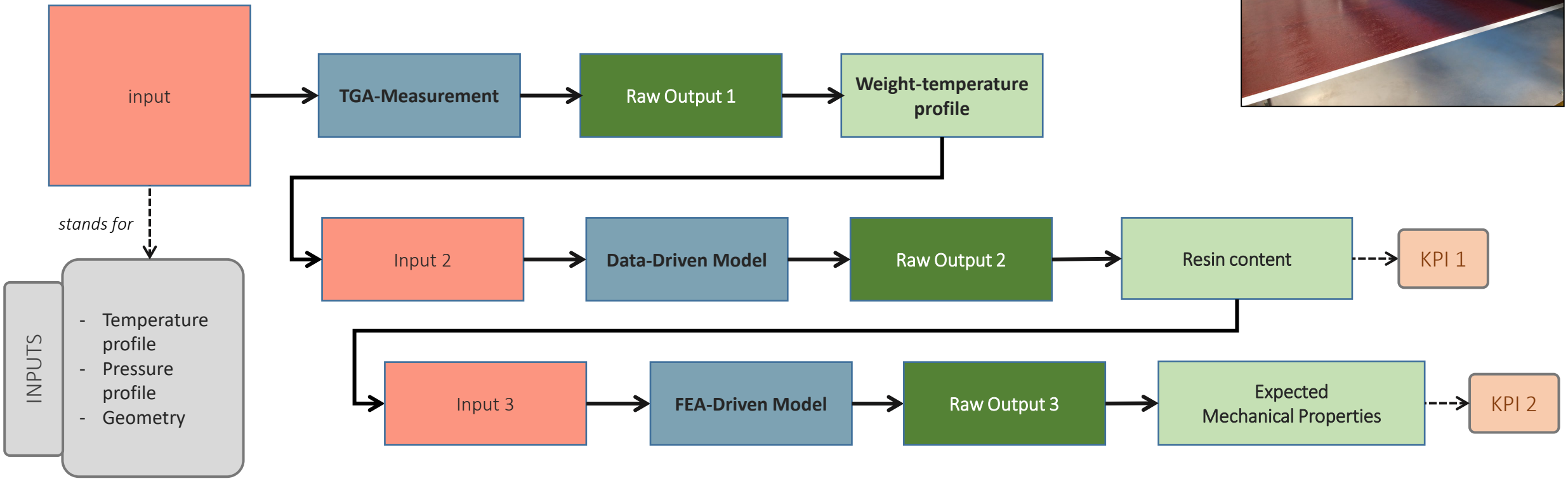

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Model Validation

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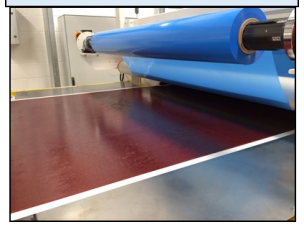
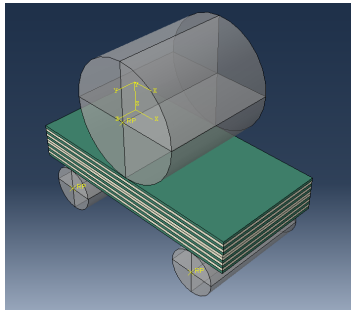
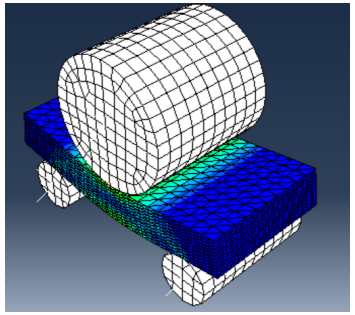
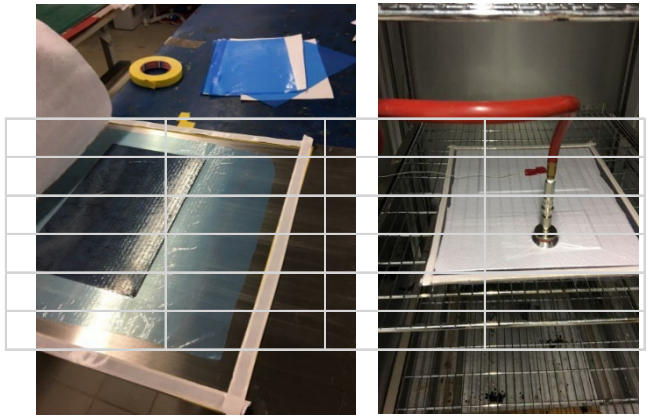


Simulation





Manufacturing



Testing

Validation

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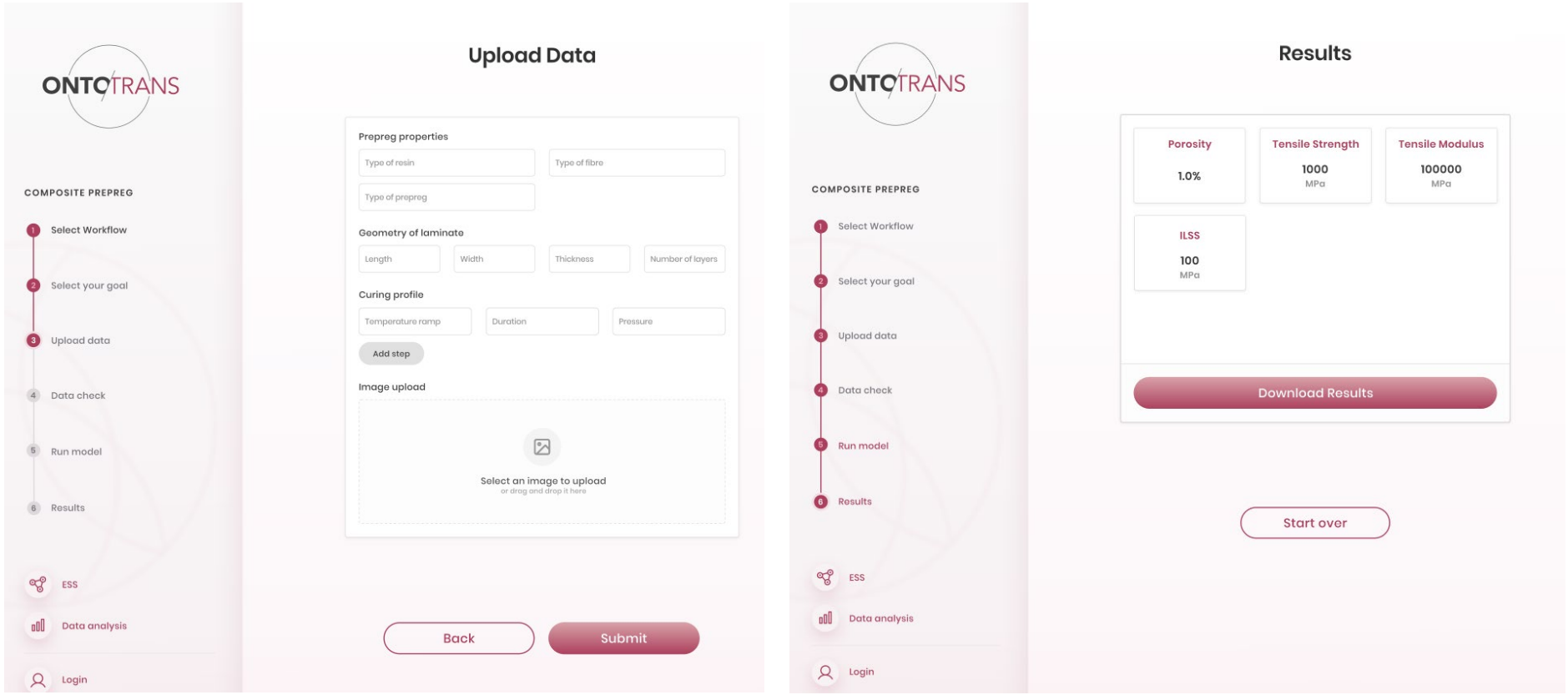
APP3 GUI of OTE



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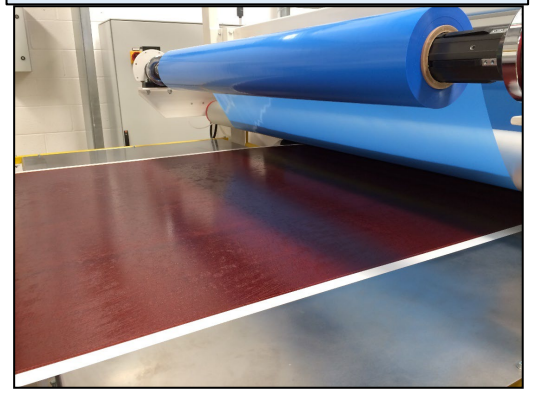
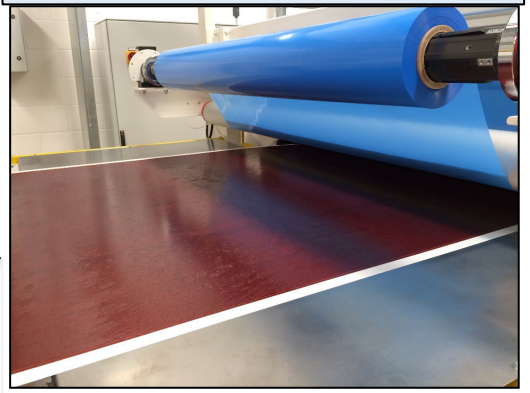


APP3 ESS

APP4 Composite Prepreg (CompEvo)



prepregging

ALL | PREPREGGING | TEXTILE FABRIC | FORMULATED RESIN | PREPREG ROLL

20 results (39 milliseconds)

Prepregging 7
Prepregging - Thing
Description of Prepregging 7

Prepregging 2
Prepregging - Thing
Description of Prepregging 2

Prepregging 5
Prepregging - Thing
Description of Prepregging 5

Prepregging 8
Prepregging - Thing
Description of Prepregging 8

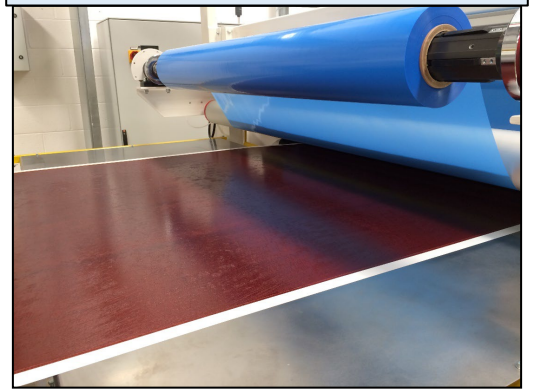
Prepregging 7
Prepregging - Thing

Description of Prepregging 7

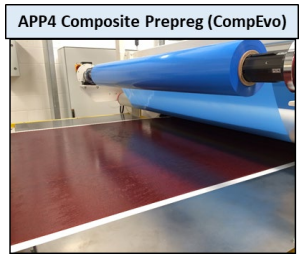
HasInputResin: Resin 2
HasInputFabric: Fabric 5
HasManufacturingMethod: Closed Molding
Laminate_length: 1567 mm
Laminate_wide: 112 mm
Laminate_thickness: 0.7 mm
Laminate_layer_count: 17
Curing Steps: Curing Step1, Curing Step 2
HasManufacturedOutput: Prepreg Roll 7

Advantage from OntoTrans

APP4 Composite Prepreg (CompEvo)



- Data-driven approach allows for a faster integration of new materials/processes
- Data-driven approach allows the prediction of composite laminate properties
- Faster response by manufacturer to customer requests
- Time-to-market can be reduced based on data-driven approach



Advantage from OntoTrans

Translator

End User

…running simulations

…data provenance

…define suitable KPIs

…guidance during translation

OntoTrans:
Open Translation Environment (OTE)

Interface with OSPs

OntoKB

ESS

Interface with BDSS

Ontological specification

APP-specific GUIs

Recommendation System (OntoRec)