Mat4Rail: Research on fire safe composite materials within the Shift2Rail programme

Fire protection of Rolling Stock 2018, Berlin 2018-03-01
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Content of presentation

- Shift2Rail: the research program
- Mat4Rail: the project
- Fire safety challenges of lightweight composites
  - Reaction-to-fire
  - Fire resistance
- Mechanical performance of composites
- Key facts and contact
Shift2Rail

A public-private partnership, a platform for the European rail sector as a whole to work together to drive innovation

• Manage all rail focused research and innovation actions co-funded by the Union
• S2R Undertaking created in 2014 and fully operational in 2016
• Long-term platform for research, until 2024
Shift2Rail

- **Members**: 8 founding members, 12 associated members, 7 associated members (consortia)
- **Budget**: 976M EURO (450M S2R-H2020 and 517M Railway sector)
- **Projects**: closed (members) and open (non-members)
- **Calls**: 2017 (112M; 93M+19M), 2018 (155M) – closing April 24
Mat4Rail in Shift2Rail

From the call for proposals in 2017:

  - Mat4Rail (open call)

- S2R-CFM-IP1-01-2017: “Development of new technological concepts towards the next generation of rolling stock, applied to major subsystems such as Carbody, Running Gear, Brakes, Doors and Modular interiors”
  - PIVOT (complementary project from closed call)
Mat4Rail

Designing the railway of the future:
Fire resistant composite materials and smart modular design
Europe’s railway industries require a step change in technologies and design for the next generation of rail vehicles to remain globally competitive.

Available structural composites do not meet Fire, Smoke & Toxicity requirements of the railway sector.

Innovative, energy- and cost efficient materials needed.
Project Objectives

- Reducing train weight by replacing metal parts with Fibre Reinforced Polymers (FRPs)
  - Develop FRPs
  - Develop structural joints for FRPs
  - Innovate access door system
Project Objectives

• Increasing capacity and passenger comfort via built-in modularity of train interior design
  - Innovative plug & play system
  - Innovative seats
  - Innovative driver’s desk
Consortium
Work Streams

**Work Stream I: Materials**

- WP2: New materials for rolling stock
- WP3: Structural joints for railway applications
- WP5: Access door systems
- WP4: Testing and characterisation

**Work Stream II: Interior Design**

- WP6: Innovative plug & play systems
- WP7: Innovative seats
- WP8: Innovative driver’s desk

WP9: Dissemination and exploitation
Research areas

Materials

- Resin development, fibre selection and composite manufacturing
  - Benzoxazine resins (UNI-HB)
  - Epoxy resins (CIDETEC, AIMPLAS)
  - Fibres (CENTEXBEL)
  - Manufacturing (COEXPAN, CIDETEC, UNI-HB)
  - Resin manufacturing (HUNTSMAN)

- Joining technologies
  - Adhesive bonding (ITAINNOVA, UNI-HB)
  - Mechanical fasteners/connectors (UNI-HB)

- Characterisation and testing
  - Load cases development (IMA)
  - Accredited FST testing (SP/RISE)
  - Mechanical Testing (IMA, SP/RISE, CIDETEC, UNI-HB, ITAINNOVA, AIMPLAS)

Interior design

- Plug & play systems
  - Inductive charging (ESCATEC)
  - Design (NVGTR, SPIRIT)

- Innovative seats
  - Design (NVGTR)
  - Textiles (CENTEXBEL)
  - Railway seat manufacturer (GRAMMER)

- Innovative driver’s desk
  - Design & Concept (SPIRIT)
  - Engineering (INDAT)

Access doors

- Aeronautic doors (COEXPAN)
- Railway doors aluminium (ASAS)
- Door leaves engineering (ITAINNOVA)
Reaction-to fire

Reaction-to-fire = the production of heat, smoke and toxic gases of a material/product

**EN 45545-2, “Railway applications – Fire protection on railway vehicles – Part 2: Requirements for fire behaviour of materials and components”**
### Reaction-to fire testing in M4R

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<tbody>
<tr>
<td>R1, R7, R17</td>
<td>X (50 kW/m²)</td>
<td>X (50 kW/m²)</td>
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<td>R8</td>
<td>X (25 kW/m²)</td>
<td>X (25 kW/m², with pilot flame)</td>
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<td>R22, R23</td>
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<td>X (25 kW/m², with pilot flame) only smoke</td>
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<td>X</td>
<td>X (600 °C)</td>
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<td>R24</td>
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**Sample size**

- 100 x 100 mm
- 75 x 75 mm
- 800 x 155 mm
- 230 x 1050 mm
- 80-150 mm x 10 mm x 4-10 mm
- 1g
Fire resistance

*Fire resistance = fire insulation, smoke and flame tightness and structural integrity of a construction*

Fire resistance, design and tests

- **Design aspects with respect to fire resistance**
  Design concepts with respect to insulation and fire protection on the level of components for FRP materials and joints (mineral wool insulation, protective coating)

- **Testing and demonstration of fire resistance**
  Implementation of design solutions and tests to evaluate the fire resistance of FRP materials and joints applications
Example of full-scale fire resistance test with FRP sandwich wall construction

Integrity (E), insulation (I), and load bearing capacity (R) were all maintained for more than 60 minutes

M. Rahm and P. Blomqvist, “Fire testing on cork - furan/glass fibre sandwich panel for marine application”, SP Report 2015:15
Reduced scale furnace in M4R

Temperatures in the mini furnace

- C1, Left plate TC [°C]
- C2, Middle plate TC [°C]
- C3, Right plate TC [°C]
- ISO 834 Standard time temperature curve [°C]
- Permitted deviation [°C]
- C4, Top centre steel plate surface temperature [°C]
Mechanical properties

Development of design load assumptions for fatigue strength assessments from measurements

- Design loads are given in e.g. EN 12663 but are valid for metallic structures
- For new materials, e.g. composites, the knowledge of real load spectra is necessary
- Measurements, statistical analysis and finite element analyses are tools for acquiring local test loads

Contour plot of calculated forces on a car-body of a tram.

Testing of mechanical properties

Testing of mechanical **static** (tensile strength, shear strength, etc.) and **fatigue** properties

- FRP composites
- Joints
- Repairs

*Test apparatus for mechanical properties.*
Mat4Rail Key Facts

Funding Programme
Horizon 2020 / Shift2Rail Joint Undertaking

Duration
01.10.2017 – 30.09.2019 (2 years)

Budget
3.5 million euro

Project Website
www.mat4rail.eu
Contact

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Testing and characterisation (WP4)
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