Mat4Rail a Project of the S2R JU Newsletter 01 | June 2018

The project behind the trains of the future

What Mat4Rail is all about and who is involved

Global challenges such as climate change or rising traffic demands call for the railway sector to take on a larger share of the passenger and freight transport demand. At the same time, the European railway manufacturing industry finds its leadership being challenged by a rapidly changing sector and new market entrants, notably from Asia, offering attractive products at low prices.

In response to these challenges, the European Commission and the European rail industry jointly launched the Shift2Rail Joint Undertaking (S2R JU). It is a public private partnership in the rail sector, providing a platform for cooperation that pursues research and innovation activities in support of the achievement of the Single European Railway Area and the improvement of the attractiveness and competitiveness of the European rail system. The goal is to double the capacity of the European rail system, increase its reliability and service quality by 50% while halving life-cycle costs. In order to achieve these goals a multi-year strategic research agenda has been developed, mapping out in great detail all the innovations required in the diverse components of a rail system, from the tracks and the rolling stock all the way to the IT systems and operating procedures. While the majority of the Shift2Rail research projects are carried out exclusively by the S2R JU members, sometimes external expertise is sought through "Open Calls" for applications to solve specific research and development questions.

Figure 1 Designing the trains of the future

Mat4Rail is one of these projects funded through a Shift2Rail Open Call. It is concerned with the following three different components of trains:

1. the carbody, i.e. the main load bearing structures;
2. the train doors; and
3. the interior design.

Objectives

The overall aim of the 2-year Mat4Rail project is to lay the foundation for:

- Reducing train weight by replacing metal parts with Fibre Reinforced Polymers (FRPs)
- Increasing capacity and passenger comfort via built-in modularity of train interior design

To reach these objectives, the Mat4Rail project is organised in two work streams:

Materials research

The newly developed materials have to meet all requirements of the railway environment regarding fire, smoke and toxicity, mechanical performance, and cost-effective manufacturing. Under the Mat4Rail project, new resin formulations are being developed and three different fibres are being tested to identify the most economically competitive composite material. Additionally, joining technologies are being developed and tested for primary, load carrying, multi-material structures for carbodyshells.

Mat4Rail also aims at achieving lighter train doors considering thermal insulation and acoustic attenuation by investigating novel concepts and novel materials.

Designing train interiors

In the project's design work stream, Mat4Rail has three main objectives in terms of improving train interior design. Firstly, a "plug & play system" is being designed. The goal of this modular interior design concept is to easily adapt or change interior elements of a train with new or existing elements. Secondly, Mat4Rail is designing new innovative seats with the highest possible flexibility and ultra-light weight. Finally, Mat4Rail is redesigning the driver's desk. The cockpit concept will be ergonomically optimised und built up from small components.

Benefits

The Mat4Rail project results benefit various stakeholder groups such as the rail supply industry, rail operators, passengers, and the European economy as a whole. It enables the introduction of new composites in the market available for the rail supply industry, to reduce the weight of carbodyshell sections by up to 30% by developing lightweight FPRs, and optimise access door systems in terms of architecture and materials. Furthermore, new functions are being integrated in the carbodyshell and space for interior is being increased, as well as new joint concepts being developed. Moreover, the innovation for seats and the driver's stand will improve capacity, performance and comfort, and over the long run, Mat4Rail will create commercial opportunities for the rail supply industry.

The Mat4Rail consortium

The multidisciplinary and innovative developments in Mat4Rail are only possible with the experience and support of an international consortium of 16 partners led by CIDETEC, a Spanish research institute. The consortium includes public and private research organisations as well as small and medium-sized enterprises and large industries. All of them are simultaneously working on developing lightweight and smart rolling stock for a more sustainable future.

CIDETEC (CIDETEC), Spain

CIDETEC is a is a private organisation for applied research located in San Sebastian, Spain, founded in 1997 whose goal is to provide value to companies by means of capturing, generating and transferring technological knowledge. CIDETEC is comprised of three international technological reference institutes in Surface engineering, Energy Storage and Nanomedicine. In addition to the 34 projects of the 7th Framework Program (8 of them as coordinators) where CIDETEC took part, currently CIDETEC participates in 23 projects H2020 projects, leading 9 of them.

In particular it is the Unit of Polymers and Composites from CIDETEC Surface Engineering Institute who coordinates the Mat4Rail project. Apart from their coordinating duties, CIDETEC leads WP2: New Materials for Rolling Stock, contributing to the development of epoxy resins with improved fire resistance, being involved in the selection of the most suitable manufacturing methods for composite manufacturing with such resins. Additionally CIDETEC is involved in mechanical characterizations in WP4, and participates actively in WP9 in Dissemination and Exploitation activities.

Universität Bremen (UNI-HB), Germany

UNI-HB brings vast experience in developing resins and joining technologies and experience from participating in Roll2Rail, one of the key relevant EU-projects for Mat4Rail. UNI-HB are leading WP3: Development of structural joints for railway applications and will follow two tracks: (i) to develop a fire resistant resin on the basis of benzoxazines (in WP2) and (ii) to investigate and further develop structural joining technologies which are capable of joining dissimilar materials on the basis of the results obtained in Roll2Rail.

Instituto Technológico de Aragón (ITAINNOVA), Spain

ITAINNOVA is a non-profit technology centre whose main objective is to promote competitiveness in the industrial sector by means of the development, acquisition, adaptation and transfer of innovative technologies. ITAINNOVA, who bring vast expertise in design and prototype of components for transport applications is participating in WP3: Development of structural joints for railway applications, mainly in the tasks related with non-permanent techniques for joining dissimilar materials (metal-composites-plastics) allowing refitting operations, and in WP5: Access door systems, applying their expertise in product development and optimisation, introduction of new materials and composites in new applications and joining/integration techniques.

Centre Scientifique & Technique de l'Industrie Textile Belge (CENTEXBEL), Belgium

CENTEXBEL is the Belgian scientific and technical centre for the textile and plastic converting industry, with strong links to the majority of these companies. CENTEXBEL will mainly be working on WP2 for the part related to the fibres. Their focus is on the compatibilisation of the potential fibres (glass, carbon, basalt) with the novel resins via coupling agents. Furthermore, Centexbel will also contribute to the fabric part of the seat development in WP7.

RISE Research Institutes of Sweden AB (RISE), Sweden

RISE is an accredited testing laboratory with merits both regarding fire and composites (e.g. the FIRERESIST project) and smoke

toxicity (e.g. TRANSFEU project). They conduct research, testing and certification of products related to fire safety as well as mechanical safety. As leader of WP4: Testing and characterisation, RISE will provide competence and a wide ranging testing capability regarding the fire and mechanical safety of materials and products developed within the project. RISE will provide expertise in flame retardancy and reaction-to-fire performance in the development phase.

Asociación de Investigación de Materiales Plásticos y Conexas (AIMPLAS), Spain

AIMPLAS, Technological Institute of Plastics located in Valencia, is a private, non-profit association founded in 1990. AIMPLAS have an excellent track record in developing new thermoset resin formulations and improve transformation processes. They will be involved in WP2: New materials for rolling stock, to improve fire performance as well as support of WP4: Testing and characterisation of resins, composites and joints.

IMA Materialforschung und Anwendungstechnik GmbH (IMA), Germany

IMA is a leading industrial test and measurement provider with accredited labs for mechanical strength analysis of railway components and is involved in the European and national standardisation for the strength of railway vehicles. IMA can provide support throughout the entire product development process, helping to verify product's durability, function and safety. They are responsible for the determination of load cases and the mechanical testing in WP3: Development of structural joints for railway applications, WP4: Testing and characterisation of resins, composites and joints, and WP5: Access door systems.

Huntsman Advanced Materials GmbH (HUNTSMAN), Switzerland

HUNTSMAN is a world leading resin manufacturer and is supplying high-performance epoxy, benzoxazine and other resins and adhesives for many industries. Within WP2, HUNTSMAN will develop and submit to the partners the needed chemistry, specifically benzoxazine based solutions and epoxy based components for formulation work as well as formulated systems fulfilling the standards related to fire retardancy (EN 45545-2) coupled with enhanced mechanical performance for the use in direct processes as well as for the the prepreg-process. Additionally they will develop a novel hybrid chemistry with low viscosity, focussing on direct processing methods.

Coexpair SA (COEXPAIR), Belgium

COEXPAIR is a highly innovative SME from the aeronautics sector and have designed and manufactured composite doors in that sector. They use their expertise in composites to make their know-how of innovative processes, the development of out-of-autoclave technologies, their tooling and peripheral equipment available for Mat4Rail. COEXPAIR leads WP5: Access door systems and contribute actively to WP2: New materials for rolling stock.

ASAŞ Alüminyum Sanayi ve Ticaret A.Ş. (ASAS), Turkey

ASAS, a specialist in manufacturing lightweight aluminium parts (including train doors) has been producing railway aluminium systems for many years and share their knowledge on the current door leave structure, material and experience in WP5: Access doors systems. ASAS provide co-design structure, select materials, characterisation, material development, testing and control support for weight reductions, acoustic and thermal conduction.

NVGTR Gbr (NVGTR), Germany

NVGTR Gbr is an experienced product innovation & design consultancy based in Munich, creating tangible visions for all mobility industries. They have developed new seating concepts & principles for super light and flexible seating systems, created the airport commuter train for the Munich Airport to come and were also active in creating & developing design languages and aircraft interior systems for some of the major players. NVGTR are leading WP6: Innovative plug & play systems and WP7: Innovative seats. NVGTR also are in charge of specific collaboration issues between consortium partners on all interior and industrial design themes.

Spirit Design – Innovation and Brand GmbH (SPIRIT), Austria

SPIRIT is an internationally leading strategic design company headquartered in Vienna. They developed the interior and exterior design of the ÖBB Railjet and the City Airport Train as well as the industrial design for numerous other trains and the innovative cockpit concept for the new airport fire-fighting vehicle "Panther" of Rosenbauer. SPIRIT leads WP8: Innovative Driver's Desk and supports WP6: Innovative plug & play systems, by providing the creative and mechanical design.

ESCATEC Switzerland AG (ESCATEC), Switzerland

ESCATEC provides fully-integrated electronic and mechatronic design services and manufacturing solutions which enable organisations to operate more profitably, sustainably and efficiently. Within Mat4Rail, ESCATEC contributes to WP6: Innovative plug & play systems. Investigating passengers' and system providers' requirements is one of the major tasks of the first phase.

Subsequently, a creative idea generation and idea condensation phase will result in tangible prototypes of the most promising solutions.

GRAMMER Railway Interior GmbH (GRAMMER), Germany

GRAMMER, an expert for railway seat manufacturing, specialise in the development and production of components and systems for automotive interiors as well as suspension driver and passenger seats for on- and off-road vehicles. GRAMMER contribute mainly to the development of innovative seats (WP7) in terms of light weight seat. The focus is on using new materials which are not common in the railway industry, but still fulfil certain requirements regarding fire safety and strength.

INDAT GmbH (INDAT), Austria

INDAT manufacture prototypes, one-off, pilot and production quantity items, including all necessary moulds, jigs and tooling. INDAT support WP8 in the development of a new driver's seat concept by offering advice on construction and engineering as well as by realising the virtual prototype in form of a physical mock-up.

accelopment AG (ACCEL), Switzerland

ACCEL assists companies, universities and other organisation in EU project management and the dissemination and exploitation of project results. Its experienced team is specialised in European research, development and innovation support programmes such as Horizon 2020. In Mat4Rail, ACCEL assists CIDETEC in the project management and organisation, supports all partners with administration, finances and reporting, and is also in charge of the risk management with a dedicated Risk Manager. Additionally, ACCEL leads the WP9 "Dissemination and Exploitation" and fosters the communication in and outside of the consortium to achieve maximum outreach and impact.

Mat4Rail at the Baltic Sea

Preliminary results of Mat4Rail resin development were presented in the Epoxy and Resins Conference held on a cruise boat between Stockholm and Helsinki the 14th-17th May, 2018

On the 14th May 2018 the opening of the biannual 2018 Spring edition of the Baltic Conference Series (BCS) was celebrated, organized by the International Association of Advanced Materials and VBRI Sverige AB. The conference took place in a cruise ship between Stockholm (Sweden) and Helsinki (Finland), and included parallel sessions in different fields of new age technology and innovation such as **Carbon Materials and Technology, Plastics and Rubber, Epoxy and Resins, Pulp and Paper Technology** and **Wood Technology**.

CIDETEC, coordinator of Mat4Rail and leader of the material development efforts in the project participated in the Epoxy and Resins Conference with the oral communication "Towards a composite based carbody: Improving the FST properties of epoxy resins", which was presented by CIDETEC´s researcher Sandra Gómez-Fernández and was developed with contributions from HUNTSMAN Advanced Materials, AIMPLAS, a Spanish research organisation specialised in plastics and RISE, the Research Institutes of Sweden. This work included an overview of the latest results obtained in the development of new epoxy resin formulations with improved flame retardancy, for their further application in fibre reinforced polymers.

These fibre reinforced polymers, which are aimed to be used in the railway industry, need to comply with the demanding EN 45545:2 "Railway applications – Fire Protection on Railway Vehicles" standard. Owing to the intrinsic flammability of epoxy resins, their formulation needs to be improved in order to develop safe and lightweight materials that meet the specifications of the railway regulation.

For this reason, the impact on the properties of epoxy resins by using different flame retardant approaches was depicted and discussed in this conference, analysing properties such as glass transition temperature, onset curing temperature, thermal stability, tensile properties as well as ignitability and flame spread.

The conference was attended by more than 120 participants. The active participation, feedback and questions of the attendees were an excellent demonstration of the high interest that Mat4Rail research arises. Congratulations to the Mat4Rail team for this excellent presentation!

Figure 2 Impressions from the Baltic See Conference

Mat4Rail's interior design team meets complementary PIVOT experts in Paris

Both Shift2Rail projects agreed on specifications for key train modules

Mat4Rail, a H2020 Shift2Rail project funded under the Innovation Programme (IP) 1; "Cost effective and Reliable trains including high capacity trains and high speed trains" of the Open Call scheme, runs parallel to PIVOT, a complementary project of Shift2Rail members. The idea of Mat4Rail is to fill some technological gaps related to the carbody shells, doors and access door systems and modularity in use (interiors) which were identified by the Shift2Rail members. The aim of the meeting in Paris was to set the specifications with a focus on interiors.

The design team of Mat4Rail consists of experts on seats, driver´s desk (cabin) and overall new plug&play systems and was represented at the meeting by participants from SPIRIT, NVGTR, ESCATEC and Mat4Rail´s coordinator, CIDETEC. From PIVOT, train manufacturers and operators, like SNCF, Siemens and Deutsche Bahn were also present. An informal meeting, which was held at SNCF facilities in Paris, clearly helped to take the first fruitful steps together towards a real collaboration between these two Shift2Rail (S2R) projects.

The two projects were not meeting for the first time as an initial encounter had already taken place in Munich, December 2017, at Deutsche Bahn facilities, to present the overall objectives of the ventures to one another and to discuss technological novelties in relation to driver cabin.

For an innovative design to be brought to life, the two consortia are to keen to develop a common vision as a novel design has the potential of a being implemented by the industry and accepted by the future user. The joint vision is the main challenge at this state of the research project; the sensibility towards an innovative design is coined by the freedom of design and reality of the manufacturers. Here, it is worth focusing on the development as the potential is very high to innovate the train industry. PIVOT together with Mat4Rail clearly aim on innovations that have a real impact on shaping the future of the train industry, said that, the way to travel by train in general.

Figure 3 Mat4Rail and PIVOT designers in Paris

Mat4Rail on Tour

From the Atlantic to the Baltic Sea

Since the start of the Mat4Rail project on 1st October 2017 the project partners have been actively informing and promoting the Mat4Rail project at various events all over Europe. To date, the presentations predominantly focused on introducing the project, its goals and how the partners are planning on achieving these. An overview of the events at which Mat4Rail has been presented can be found below.

Mat4Rail Kick-off Meeting

From 4th-5th October 2017, Mat4Rail members representing the 16 Beneficiaries attended the Mat4Rail kick-off meeting at CIDETEC in San Sebastián, Spain to discuss the project and the network's potential for the trains of the future. For most of the Mat4Rail partners, this meeting was the first face-to-face meeting and the first time the whole consortium came together.

Fire retardants for thermoplastics and thermosets workshop

AIMPLAS organised a workshop on various topics relevant to fire retardants for thermoplastics and thermosets, 14th-15th November 2017. The workshop held in Spain attracted 72 participants who over the course of the two days where presented valuable information on fire retardants, safety and regulations as well as given the chance to network with attendees working in a similar field.

Shift2Rail JU Events

The Shift2Rail Joint Undertaking (S2R JU) currently supports 44 ongoing projects under the framework structured into five asset-specific Innovation Programmes (IPs) to cover all the different structural (technical) and functional (process) subsystems of the rail system. To support these ongoing projects the S2R JU offers various information and networking events to support knowledge sharing and innovation at which Mat4Rail has been represented by the coordinator, CIDETEC.

- Shift2Rail JU Steering Committee, 16th January 2018
- Shift2Rail JU Info Day, 12th December 2017
- Shift2Rail JU Project Coordinators Info Day, 14th November 2017

KMM-VIN Working group 1: TRANSPORT

The KMM-VIN is a new model for European research on advanced materials which allow European institutions to share their expertise. It is divided into different working groups of which the Mat4Rail coordinator, CIDETEC, is part of. The working group "Materials for Transport" focuses on the development of materials for transport applications. An overview of Mat4Rail and the main activities under development in the project were

presented by Mat4Rail´s coordinator Elena Jubete, from CIDETEC, 28th February 2018, in Brussels at the Transport Working group of KMM-VIN association.

FPRS 2018

The Fire Protection of Rolling Stock 2018 (FPRS) took place over 2 days, 28th February -1st March 2018 in Berlin, Germany and focused on taking an in-depth look at the biggest challenges and opportunities in the sector. The event delved into the technical and strategic innovations impacting the sector and explored as a group what more can be done to set and improve standards.

Figure 5 Per Blomqvist presenting at FPRS 2018

Per Blomqvist, from Mat4Rail's partner, RISE, held his presentation on Mat4Rail with a focus on research on fire safe composite material within the Shift2Rail programme. RISE is involved within the Mat4Rail project as work package leader for testing and characterisation of composites and joints. His presentation is available online.

Mat4Rail General Assembly

The 2-day Mat4Rail General Assembly (GA) was organised by Mat4Rail's partner University of Bremen (UNI-HB) in Bremen Germany, 24th-25th April 2018. The GA brought together 30 participants from the 16 project partners to discuss the progress and achievements during the first 7 months of the project and to plan the next steps. Further meetings and workshops between the two working streams, Design and Materials, were held to discuss advances and share knowledge in detail within the project's expert groups. The Mat4Rail Executive Board also held a face-to-face meeting to discuss overall project progress and potential risks of this ambitious research and innovation action.

Baltic See Conferences

Sandra Gomez from CIDETEC presented initial results on improving the FST properties of epoxy resins during the Epoxy and Resins Technology Conference 2018 in Stockholm, Sweden.

The conference provided a unique opportunity for researchers from industry, academia and research centers to come together to review their collective progress, consider the latest developments and discuss the future challenges in Epoxy and Resins Technology. Further information on the Mat4Rail results presented can be found in the newsletter article on "Mat4Rail at the Baltic Sea".

Mat4Rail-PIVOT carbody workshop

Mat4Rail together with PIVOT held a carbody collaborative workshop at CIDETEC, 19th-20th June 2018. The objective of this workshop was to revise the specifications gathered for the development of the novel composites and joints being developed in Mat4Rail to be able to later be implemented into PIVOT carbody demonstrators.

Additionally, Mat4Rail shared their results from the fire and mechanical testing of the first materials. The productive meeting received valuable input with high collaboration between rail manufacturers, rail service suppliers and top researchers from both Shift2Rail projects.

Figure 6 Mat4Rail and PIVOT partners

Planned Events

Mat4Rail partners have already started planning on attending future events to introduce the project and later the Mat4Rail related project results. Listed below are a number of future events where members of the project plan to represent Mat4Rail.

- International conference on composite structures (ICCS 2018), 4th-9th September 2018, Dresden, Germany
- SAMPE Europe Conferences, 11th-13th September 2018, Southhamption, UK
- Internationale Rad-Schiene-Tagung Dresden 2018, 12th-14th September 2018, Dresden, Germany
- InnoTrans 2018, 18th -21st September 2018, Berlin, Germany
- Mat4Rail General Assembly Meeting, 26th-27th September 2018, Borås, Sweden
- International Conference on Composites, 2nd-3rd October 2018, Liège, Belgium

Mat4Rail
a Project of the S2R JU

Designing the railway of the future

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- Universität Bremen, DE
- Instituto Technológico de Aragón, ES
- CENTEXBEL, BE
- RISE Research Institutes of Sweden AB, SE
- AIMPLAS Asociación de Investigación de Materials Plásticos y Conexas, ES
- IMA Materialforschung und Anwendungstechnik GmbH, DE
- Huntsman Advanced Materials GmbH, CH
- Coexpair SA, BE
- ASAŞ Alüminyum Sanayi ve Ticaret A.Ş., TR
- NVGTR Gbr, DE
- Spirit Design – Innovation and Brand GmbH, AT
- ESCATEC Switzerland AG, CH
- Grammer Railway Interior GmbH, DE
- INDAT GmbH, AT
- accelopment AG, CH

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