

## Digital Product Passports for Composites in the Circular Economy: Challenges and Emerging Opportunities

**Salim Belouettar<sup>1</sup>, Heinz A. Preisig<sup>2</sup>, Peter Klein<sup>3</sup>, Franz Pirker<sup>4</sup>, Natalia Konchakova<sup>5</sup>**

<sup>1</sup>Luxembourg Institute of Science and Technology (LIST), Luxembourg

<sup>2</sup>Norwegian University of Science and Technology (NTNU), Norway

<sup>3</sup>Fraunhofer Institute for Industrial Mathematics (ITWM), Germany <sup>4</sup>AC2T

Research GmbH, Austria

<sup>5</sup>Helmholtz-Zentrum Hereon, Germany salim.belouettar@list.lu

### Abstract

The shift from a linear to a circular economy has elevated Digital Product Passports (DPPs) as vital instruments for transparency, traceability, and sustainability across product lifecycles [1]. This is particularly relevant for composite materials and structures, which pose specific challenges in recycling, material recovery, and regulatory compliance [2, 3]. By consolidating essential product information such as composition, origin, environmental footprint, and compliance requirements, DPPs support material tracking, facilitate reuse and recycling, and enhance data governance across supply chains. Despite their potential, several challenges hinder the widespread adoption of DPPs, including interoperability issues, the lack of standardised frameworks, and fragmented regulatory landscapes [4]. This study, conducted by the DigiPass CSA consortium, examines the primary barriers to implementation and proposes actionable strategies to foster adoption within the composite materials sector.



DPPs are built around two essential pillars: (1) Data and Information Management, and (2) Data Analytics. The data management component encompasses the secure collection, storage, retrieval, and distribution of product data throughout the lifecycle. This includes key details such as fibre composition, resin types, manufacturing processes, and certification records. Metadata plays a key role in enabling quick and reliable access to this information, embedding attributes such as product identifiers, batch numbers, sustainability labels, and end-of-life instructions [5]. The second pillar, Data Analytics, focuses on extracting value from the accumulated data. Techniques such as predictive modelling, machine learning, and lifecycle assessment help identify trends in product performance, durability, and environmental impact [6]. These insights empower manufacturers, policymakers, and recyclers to make informed decisions, enhance resource efficiency, and minimise waste—particularly in high-impact sectors like aerospace, automotive, and construction [7]. A significant recent advancement is the emergence of Collaborative Digital Ecosystems (CDEs), which act as platforms for cross-sector collaboration. These ecosystems connect manufacturers, suppliers, regulators, and consumers, enabling real-time data exchange and collective decision-making [8].

This keynote presentation will explore the role of DPPs in enabling circular business models, with a focus on composite materials and complex products. It will highlight the need for standardised frameworks, the integration of emerging digital technologies to ensure data integrity, and the policy instruments necessary to scale adoption.

**Keywords:** Digital Product Passports, Circular Economy, Supply Chain Transparency, Composite Materials.

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