

TOSCA 101191394
Manufacturing Processes and Digital **To**ols for more **S**ustainable **C**omposite **A**erostructures

Deliverable D3.4: "Digital twin for curing and joining processes – Summary"

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Lead Beneficiary: GMI
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SEN	Sensitive information	X

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SUMMARY

This deliverable concerns a prototype software that acquires data from the curing and joining processes and related quality control and merges this data into a digital twin. The deliverable describes the structure of the digital twin and its links to the existing eco-system of software. It also includes basic information on the TOSCA novel materials (vitrimer resins), while explaining in detail the curing and joining process data collection and transfer processes, so that they could be integrated into the digital twin.

More specifically, Deliverable 3.4 presents the underlying data model based on the HDF5 (Hierarchical Data Format) technology, which was selected for its proven capability to store large, heterogeneous, and hierarchically organized datasets efficiently. The implementation follows the composite manufacturing schema developed by Dassault Systèmes, originally designed to ensure interoperability between simulation, manufacturing, and quality assessment tools. Within TOSCA, the schema has been adapted and extended to accommodate additional process and sensor data, thus enabling a continuous digital thread that links material geometry, process data, and resulting component quality through manufacturing and maintenance. It has been also further extended to include repair and joining process data, as collected by corresponding state-of-the-art equipment, focusing on the TOSCA developed vitrimer resins.

To this end, an extensive description of the state-of-the-art ANITA 4.0 IoT bonding console data collection process is included there-in, focusing on the repair process related parameters and material related specificities. Options on how to transfer the produced .pdf and .csv files are equally detailed, in order to ensure interoperability and smooth integration with the Digital Twin database.

In similar manner, the concepts of the resistance welding technology for polymers are introduced as well as the process parameters that can be recorded during the process will be explained. In the case of the welding process, the data are directly recorded in the .csv format, allowing straight-forward integration into the manufacturing database.

This Deliverable also describes and demonstrates the structure and functionality of TOSCA's manufacturing / repair / joining database, initially related to the part of the software responsible for acquiring and storing data from quality control during the lay-up process. The manufacturing database acts as digital twin framework for the produced composite components, documenting relevant data from every step of the component's life, from design parameters to process monitoring to structural health and repair data after its use, in a consistent manner across partners and process stages. To this end, a full coordination with Deliverable 4.4 "Implementation of digital twin for lay-up processes" has been established, to ensure complementarity of approach and data interoperability.

By describing both data flows and technical implementation aspects, including descriptions and writing/reading procedures, the document aims to demonstrate the practical and reproducible processes involved in data exchange within the project consortium. Ultimately, the goal is to ensure that the manufacturing / repair / joining database functions as a reliable digital twin of the composite part and its production and use history. It establishes a foundation for traceability, process optimisation, and model-based analysis, thereby contributing to the project's broader aim of integrating manufacturing and simulation data into a unified digital environment.