Enabling Multi-Functional Performance through Multi-Material Additive Manufacturing

March 2023

Newsletter 3 | Article no. 3

ISQ is developing environmental LCA models to support Bulkhead panel produced by Metal Additive Manufacturing for aerospace sector

Multi-Fun project aims to boost a significant performance and efficiency gains in metal additive Manufacturing (MAM) products integrating novel materials and muti-functionality. ISQ is leading the WP1, overseeing life cycle analysis, life cycle costing and ecoefficiency analysis, which aim to support the developments in an integrated way and provide feedback loops towards an improved economic and environmental performance.

The Life Cycle Assessment (LCA) is a methodology widely used to calculate the environmental impacts of products and services along their life cycle. Such framework is of paramount importance to give partners valuable feedback and awareness on the main environmental hotspots, in an early stage of product development, to minimise the environmental impact while decisions are made, and more freedom is available. Along the project, ISQ developed life cycle assessment studies considering alternative core metal materials to be used in the Multi-Fun demonstrators, and different LCA models for demo process steps.

The development of a MAM bulkhead panel for aerospace sector (Demo 2), undertaken by Lortek, Aerotecnic, LKR, InPhoTech, and BCM efforts, has been supported by ISQ applying standardized LCA (ISO 14040 and ISO 14044). The methodological framework comprised four main stages: (1) Goal and Scope definition, (2) Life Cycle Inventory, (3) Life Cycle Impact Assessment, and (4) Interpretation. Aiming to assess the environmental impacts associated with the additive manufacturing (AM) production route such of the bulkhead panel part development a *"cradle-to-gate"* approach was assumed, using a functional unit of 1 part produced.

The preliminary manufacturing process is depicted in Figure 1. As can be seen, an AM-based technology (cold metal transfer, CMT) was used by LORTEK to print the panel. Then, the panel's surface was finished by milling and other finishing operations in Aerotecnic facilities. In the first approach, a commercial Aluminium (Al) wire was considered.

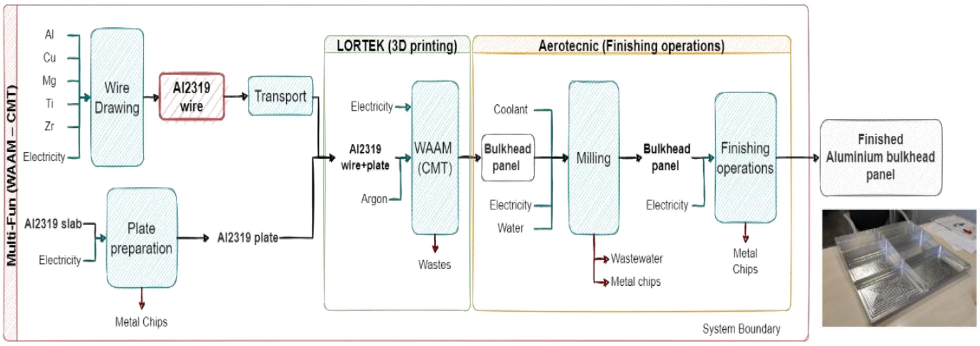

Figure 1. Flowchart of the system under study.

The environmental impacts obtained (Figure 2) showed that raw material production (metals used to produce the wire) is main hot spot of the process, accounting for up to 75% of the impacts.

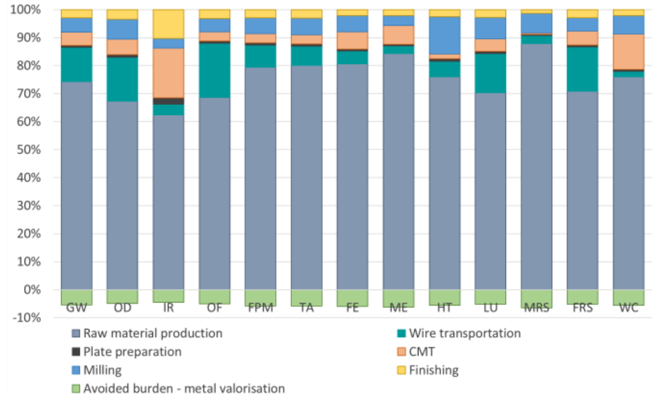

Figure 2. Environmental impacts for the process route developed under MULTI-FUN project.

The AM process (CMT) was responsible for 6% of the environmental burdens mostly due to the argon and energy consumed during the process. Other unit processes were less meaningful totalizing less than 5% of the impacts. On the other hand, the recycling of wasted raw materials has the potential to avoid up to 6% of the process environmental impacts (avoided burden).

Complementary processes that are under development (heat treatment and the integration of optical fibres (OF) that guarantee sensing capabilities) may also be included in the subsequent stages of this analysis, to estimate the overall environmental impact of this demo. Additionally, other Al-based wires will also be evaluated, including a new wire developed by LKR. The environmental impacts associated with alternative processing routes will be further compared to continue to support partners decisions and future developments.

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 862617 – MULTI-FUN