LoCoMaTech Report Summary

Project ID: 723517
Funded under: H2020-EU.2.1.3.

Periodic Reporting for period 1 - LoCoMaTech (Low Cost Materials Processing Technologies for Mass Production of Lightweight Vehicles)

Reporting period: 2016-09-01 to 2018-02-28

Summary of the context and overall objectives of the project

The LoCoMaTech project aims to reduce the manufacturing cost of the vehicle components/structures with a patented HFQ®-Aluminium manufacturing technology by Imperial College London (“solution Heat treatment, cold die Forming and Quenching”): the first technology in the world enabling manufacture of high-strength lightweight complex-shaped aluminium parts (validated and used by 4 niche vehicle manufacturers), through further developing 10 recently patented HFQ® related technologies aimed at improving cost efficiency and reducing environmental impact. The low-cost manufacturing technology developed would allow it to be used for mass production (popular) car body and chassis structures, vehicles in general, and hence, full aluminium body and chassis become possible for low-end vehicles, which will lead to substantial improvement of the energy efficiency, performance and travel range of vehicles. LoCoMaTech will construct world first low-cost HFQ® aluminium production line (prototype), targeting the reduction of energy consumption per vehicle by 15.3%, and cost-effective weight savings from 8.55 to 2.16 €/kg-saved and improvement of LCA environmental impact by 15.39%. LoCoMaTech plans to create 53 commercial production lines and 1700 jobs in Year 6 from the completion of the project.

Work performed from the beginning of the project to the end of the period covered by the report and main results achieved so far

Main research technology development achievements of the project over the past 18 months are briefly described here:

1. Integrated Cost-driven Life Cycle Approach and Implementation.

The impact of HFQ on the current process chain for niche vehicles was studied through automotive case studies to establish a base line against which to evaluate the gains achieved by LoCoMaTech. The unique set of Key Performance Indicators (KPIs), such as, 15% raw material cost reduction, 40% production rate increment and 50% overall process cost reduction for mass production, etc. were compiled into a KPI matrix to measure and ensure the success of the new HFQ® technologies developed for mass production.

2. Materials, testing and joining of material for low cost HFQ®.

The fast heating, cooling and ageing properties were determined during testing which has identified SHT reductions in time from 15 mins to less than 2 mins and fast ageing from the traditional 24 hours to less than 1 hour. The tests have demonstrated that the newly developed material is highly suitable for HFQ and can achieve significant cost and time-savings compared to traditional commercial variants. Moreover, joining tests using friction stir welding, resistance spot welding and
adhesive joining for similar and dissimilar alloys were performed which has demonstrated the capability of HFQ parts to be joined together in a post form assembly, thus enabling full structural members to be produced.

3. Fast heating and fast cooling facilities

The designed fast heating system has achieved the target heating temperature of 540°C at a heating rate of up to 60°C/s. Regarding fast cooling, a device was designed and manufactured to achieve a cooling rate of 50 to 60 °C/s on aluminium sheets. This was designed in accordance to the above achievement, as the interface heat transfer coefficient (IHTC) for a range of temperatures and pressures was first required to adequately design the cooling system.

4. Development of new tool and coating material technologies

The use of cast iron to produce tooling enables rapid tool manufacture, with complex features such as cooling channels to be designed into the casting whilst minimizing machining processes. Moreover, coatings have been developed specifically for cast iron material to maximize adhesion to the tooling material whilst minimizing the effects of galling of aluminium blanks. The coatings were developed to withstand the thermal history of the aluminium blank and minimize the use of lubricants. The use of cast iron tooling with coating has the ability to reduce the cost of traditional hot stamping tools made from high strength steels by over 70%.

5. Virtual engineering tools

The neural network software system enables the user to import the CAD model of the required component, and based on a system of trained models, the punch, die, blankholder and blank shape to successfully form the part are output. This system is also utilized for the design of tooling for the demonstrator components of the project. These virtual systems, in combination with PAMSTAMP simulation software enable the entire HFQ process to be simulated without the needed for multiple trial-and-error optimization experiments to be conducted.

**Progress beyond the state of the art and expected potential impact (including the socio-economic impact and the wider societal implications of the project so far)**

The LoCoMaTech will construct the worlds’ first low-cost HFQ® aluminium production line with the aim of reducing energy consumption per vehicle by 15.3%, and achieve cost-effective weight savings from 8.55 to 2.16 €/kg with an improvement of LCA environmental impact by 15.39%. LoCoMaTech plans to create 53 commercial production lines and 1700 jobs in Year 6 from the completion of the project. The scientific objectives of LoCoMaTech are:

1. To optimise Material Processing routes through Testing and Characterisation at HFQ®-Aluminium conditions to enable higher quality, lower cost and improved performance. In particular, this includes: (i) Optimisation of material processing routes HFQ® by considering requirements for fast heating, cooling and aging, which will reduce component manufacturing costs by 40%; (ii) T0 material production for HFQ® to reduce the cost of aluminium blank sheets by 15%; (iii) Further reduce cost by using recycled and recovered aluminium (estimated to be 10% ~ 15%); (iv) Material testing and characterisation, including multi-stage artificial ageing and formability tests; and (v) Part performance testing including crashworthiness and durability tests and verification of virtual engineering tools.

2. Development of a Virtual Engineering Platform to support process and product design optimisation for HFQ®-based production. This reflects a cost-effective approach and considers life-cycle design principles and implementation strategy for lightweight vehicle structures and component production with the aim of reducing product development cost (design and manufacture) by approximately 20%.
3. Development of a low-cost efficient HFQ mass production and prototyping facility for Al-alloy structural parts. The aim is to reduce energy consumption by 22% and increase productivity by 40% on average, and to enable customised mass-production to suit different production volumes.

In addition to these scientific objectives, there are two industrial objectives to be achieved in the project. These are:

1. Case study evaluation to demonstrate the capability of the technology and manufacturing facilities to confirm the achievement of targeted TRL 6. Currently, 1.5 million car body structures are made of aluminium at relatively high cost. Converting designs consisting of several joined components into a one-piece complex-shaped using HFQ® technology will achieve huge industrial impact as demonstrated already in niche vehicle sectors.

2. Development of an innovative integrated exploitation strategy and detailed business plan for low-cost HFQ® aluminium technologies, with a complete supply chain that is composed of design, materials, tooling, machinery, manufacturing, IT, stamping tier-1s, and OEM end-users.

Related information

Last updated on 2019-04-01
Retrieved on 2019-09-01

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