Final Report

Project acronym: *AM-Crash*
Project number: *02P18E000*
M-ERA.NET Call 2018

Period covered: 01/07/2019 to 30/06/2022

Coordinator: Dr. Martin Hillebrecht | martin.hillebrecht@edag.de |
EDAG Engineering GmbH, Germany

Publishable project summary

Project Summary

Metal-based laser additive manufacturing (LAM) technologies known as Direct Metal Laser Sintering (DMLS), Selective Laser Melting (SLM) or LaserCUSING® are able to create high performance parts featuring enormous geometrical complexity. The AM-Crash project has developed this technique for automotive sector in general and for highly dynamically loaded applications in detail. Therefore, an adaptable 3D-manufacturing concept for different crash-loaded applications in automotive Body-in-White (BIW)-structures regarding to strength and ductility requirements have been educed.

The main objective is the use of LAM parts during prototype development for crash tests, for small series car production and for spare part manufacturing. This required a complete understanding of LAM material behavior along the entire process chain as well as under high dynamic loads. The aim of AM-Crash was to achieve equivalent mechanical properties of LAM components compared to standard deep-drawn parts to allow significant cost and lead-time benefits during car development, high safety properties for small batch series components and a flexible spare part production.

To achieve this target, an identical structural behavior of LAM components and deep-drawn sheet metal was required especially regarding dynamic crash loads. Due to the deformation process of standard material, local hardening effects are influencing the part characteristic significantly. The combination of subsequent approaches was developed for a sufficient modification of LAM components regarding to:

- controlling of metallic microstructure by laser exposure parameters;
- special design features (lattice structures, local wall thickness deviations);
- post treatments for local metallic structure modification (laser hardening, ageing behavior).

A further important topic of AM-Crash was the development of suitable joining and integration technologies. The focus was on adapted welding processes. The objective was to achieve an identical joint strength property regarding strength and deformation like conventional attached assemblies.

Based on the research results, the local material behavior can be simulated in the crash model. For the first time, it is possible to model the property profile of LAM-manufactured material. The post-treatment methods, such as heat treatment and local laser hardening, are also taken into account in the models. A further goal of the project was the development of an accurate simulation model that considered the whole process chain starting from the build to heat treatment to removal of baseplate and subsequent localised post-processing. The model should also consider the material behaviour and local microstructure effects arising from the build and post processing. This was successfully achieved and now it is possible to create a digital process chain for the whole prototyping. Therefore, it is now possible to reproduce the behavior of deep-drawn sheet metal components as far as possible with LAM-produced components, taking into account the post-treatment.

The research work of the AM-Crash consortium could be validated and confirmed by means of an industry-oriented demonstrator in relation to the mapped process chain.