CHECK OF HYBRID STRUCTURES AND LIGHTWEIGHT CONSTRUCTION MATERIALS — USAGE OF 3D-CT

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Abstract. Lightweight structures and modern methods of generating samples require in most cases non-destructive-testing to verify their state. They often must not be destroyed for initial testing as they are unique and irreplaceable. So computed tomography serves well as the sample is not being touched or manipulated for the analysis.

Meanwhile in-situ testing of stable stress situations, for example pressure and tension is available and gives insight where only the measured data were before. This allows the identification of seeds for failure.

The production process can be recorded also within the sample and not only its surface. We demonstrate detectable defects in carbon reinforced plastic parts, laser sintered metal parts and an example for optimizing the process of printing a plastic part for function.

1. Introduction

As a service provider for computed tomography (CT) we are permanently involved in the latest research and recent problems of companies working on topics about aerospace, automotive, electronic development and all kinds of academic institutions. We encounter an increasing amount of fibre-based structures, lightweight materials and usage of additive production methods. Most of the samples we receive are unique and each has individual defects. The probes may not be destroyed nor modified so our customers can undertake further testing or use them for assembly in the final product.

2. Usage of CT as multipurpose solution

The biggest amount of lightweight probes we receive is made of carbon fibre reinforced plastic. We are often involved in following the production process and checking the production parameters as well as in the (mechanical) testing of the pieces.

In the following we will show examples of carbon fibre plates with different defects which were placed intentionally inside.

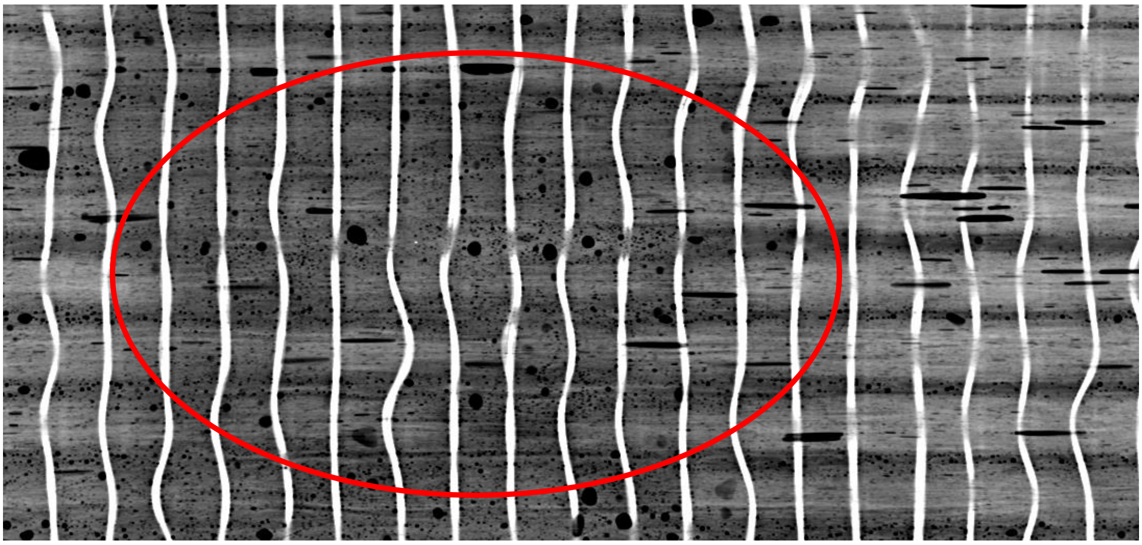

Fig. 1. Resin filled delamination (within red marking)

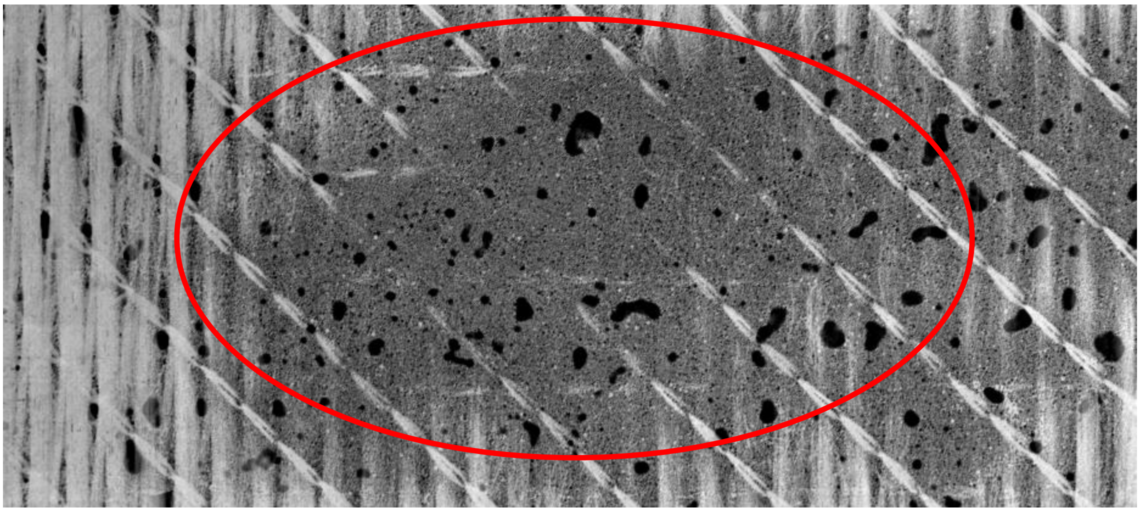

Fig. 2. Resin filled delamination (within red marking)

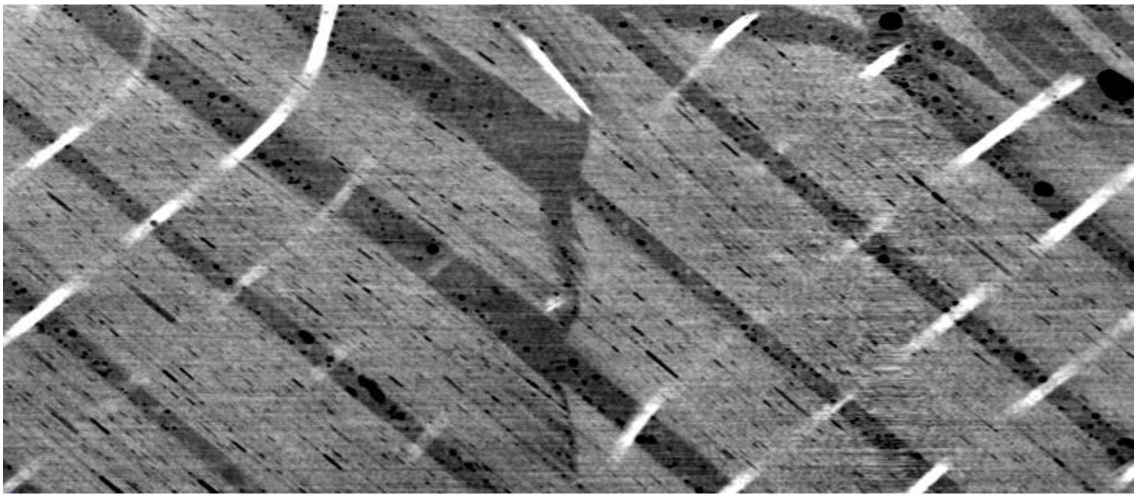

Fig. 3. Fractured carbon fibres (light grey) and glass fibres (white)

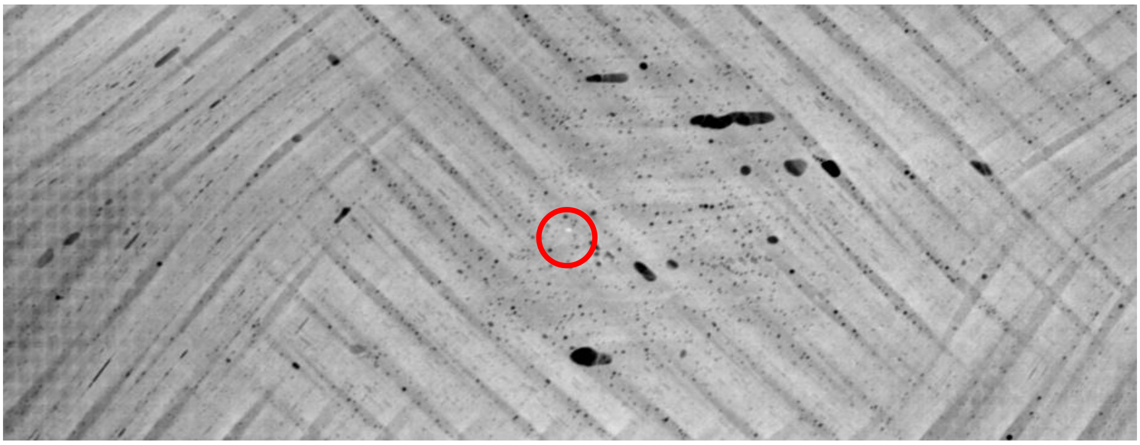

Fig. 4. Glass ball (within red marking) for simulating of inclusions

Fig. 5. Ondulation of carbon fibres (light grey) and glass fibres (white)

The number of probes made with additive production methods increases permanently for us. As our origin is in plastic injection moulding we receive many plastic parts. However are metal parts more interesting for industrial uses. With their spreading we have to make analysis with laser sintered metal parts, besides metrological classification it is important to know the inner structure of these parts. Only with CT it is possible to show defects in the whole sample at once (see Fig. 6.).

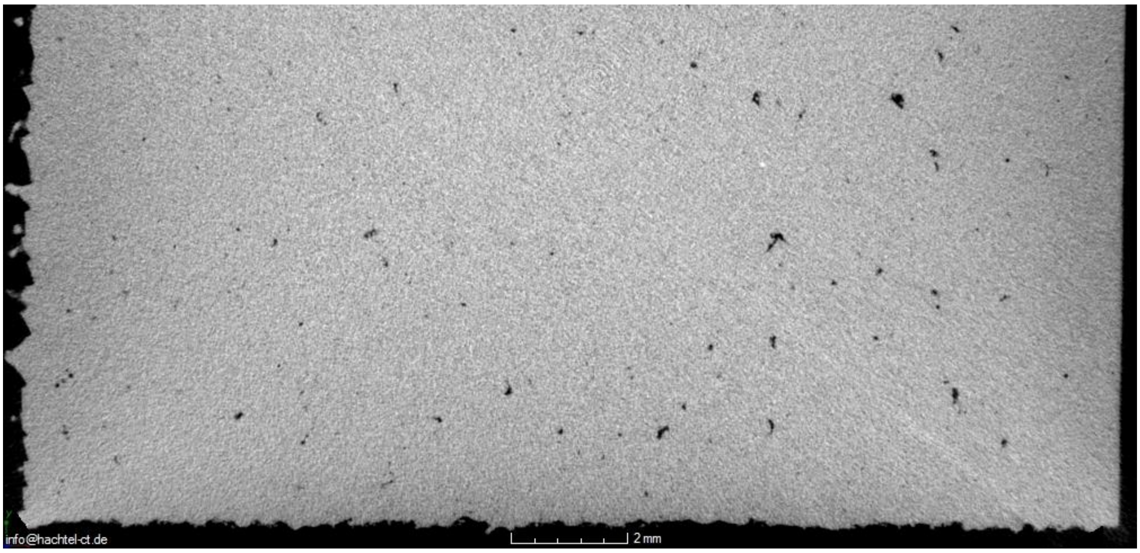

Fig. 6. Pores in a laser sintered sample from titanium

Regardless the production method parts have to fulfil a function as intended by the designer. With additive production the shapes which can be produced in one piece became nearly infinite. In the same time it got difficult to qualify them. To demonstrate the use of CT for 3D printing we took one part of our plastic production and printed it naively. As expected the printed part did not work. So we used actual-nominal-comparisons to modify the printing model in order to get a functional part (see Fig. 7.)

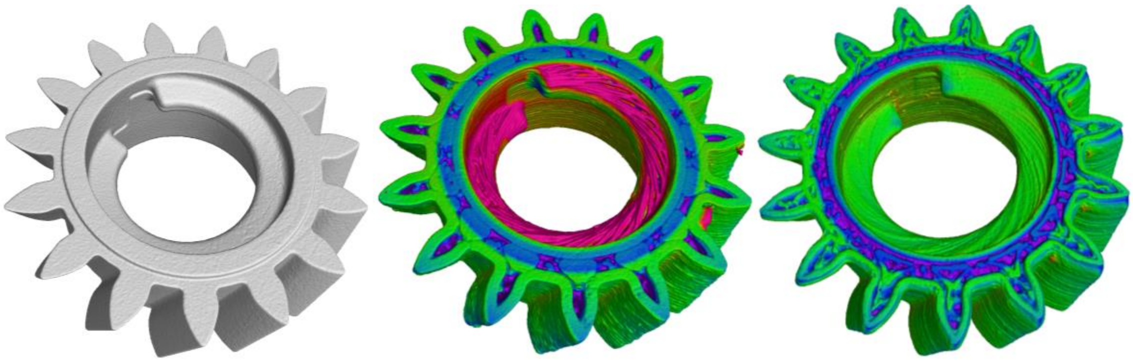

Fig. 7. Original part from injection molding (left), first print without function due strong deformations(middle), final print with full function after two correction iterations (right)

Some samples are too flexible to keep their shape during the scan or need to be scanned in a special shape. This also applies for samples which show certain defects only under stress. Cracks can be invisible if the sample is in natural shape. But if it is bent the crack might open and be detectable. This makes scans essential which show the sample during applied stress. An example for an in-situ scan is a plastic part from our injection moulding lines (see Fig. 8.). This sample is highly flexible and has a sealing from a second component going round. Only by fixing it in a device we can measure it for controlling and qualification.

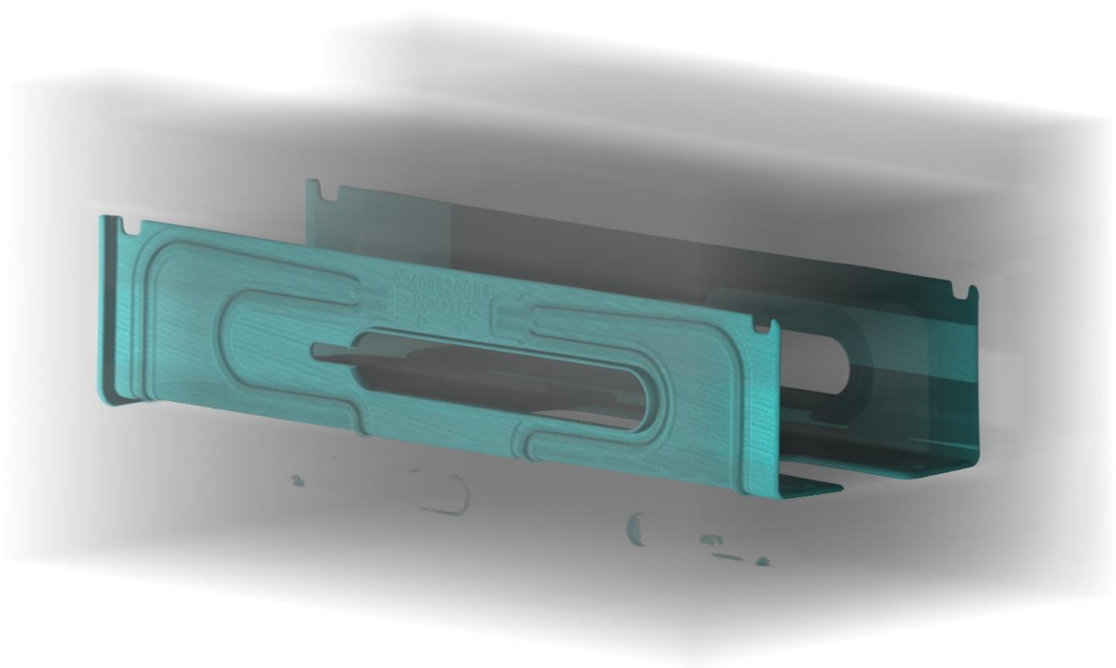

Fig. 8. Flexible plastic part (blue) with sealing as 3D rendering in fixing device (grey, transparent)

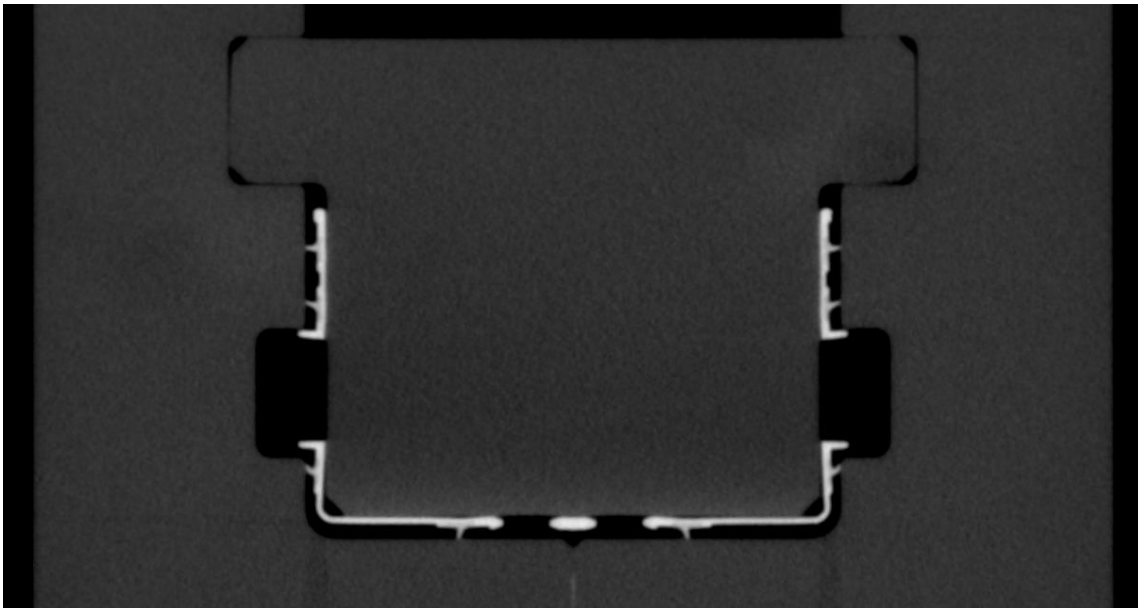

Fig. 9. Flexible plastic part with sealing (white) as 2D slice in fixing device (dark grey)

3. Summary

CT is a suitable method for analysing, detecting and qualifying a big variety of samples and materials. With the increasing demand for unique and individual parts and the development of production processes creating those, the importance of testing samples without destruction will increase. It is necessary to create and improve the knowledge and know-how of how to obtain data and their interpretation. The understanding of limits and failure of samples is available from the very same data that validate their metrological characteristics. While it is not necessary to plan the gathering of data regarding all interesting aspects it allows to recover states of samples which have been lost due to testing or use afterwards just by reopening the scan.