μCMM Application Note

Measurement of metallic exit burrs within CFRP/metallic stacks

Bruker alicona

Bruker Alicona is a leading global supplier of optical metrology solutions based on the principle of Focus Variation.

Focus Variation works on the basis of moving a focal plane over a surface and collecting robust 3D data which can then be used to measure geometric form and surface finish from a single optical sensor.

Measurement processes can be fully automated and provide GD&T measurement capabilities across all industrial & medical sectors.

The systems are in use in Industry, Industrial Research, Universities and production facilities globally.

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Introduction

A metallic burr is a ridge/raised edge that forms on the edges of a work piece where a machining operation (such as drilling and grinding) has taken place. The assembly of an aircraft requires the use of material stacks; a stack of materials which have been drilled through and held in place with a fastener. Work is being done to eliminate the need of taking apart and inspecting these stacks and carrying out rework, all of which adds additional cost to the manufacturing process (doi.org/10.4271/2011-01-2745). Burrs are known to occur not only on external surfaces, but also between stack layers which can lead to fasteners and components seating incorrectly, injuries to workers and even the potential for the stack to come loose (doi.org/10.1007/s00170-013-5112-9).

The University of Sheffield Advanced Manufacturing Research Centre (AMRC) is currently undertaking a significant number of stack drilling trials to help industry develop methods of controlling drilled hole quality and assessing it using in-process signals from drilling. This requires thousands of burrs to be inspected so that robust relationships can be drawn between the drilling processes, in-process signals and various metrics relating to the burr.[1]

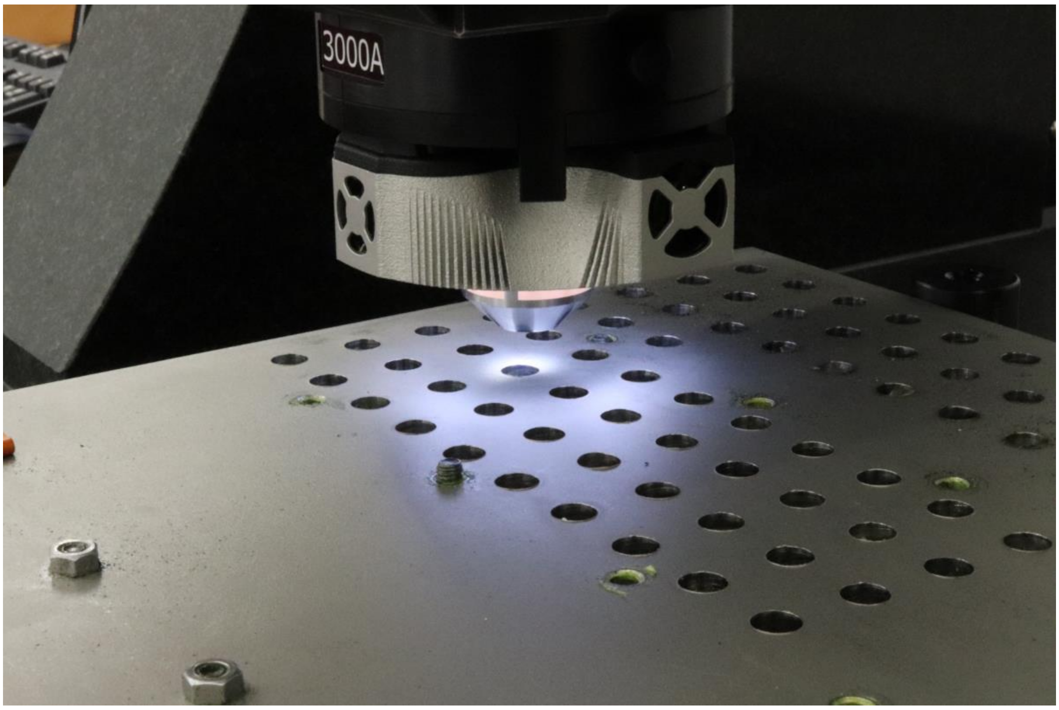
System used

The system used to perform these measurements is the Bruker Alicona µCMM. As the first purely optical CMM, the system combines coordinate measuring technology and optical surface measuring technology to measure dimension, position, shape and roughness of components within extremely tight tolerances at high accuracy. The optical system can perform both 2D and 3D measurements using Focus-Variation technology. The µCMM offers dense non-contact and material-independent measurements, integrating the functionality of a coordinate measuring machine, intuitive usability for multiple users, allowing for the measurement of all materials and composites widely used in industry and all components of the system operate contact free, providing an efficient, wear-free experience. This task can also be performed on a Bruker Alicona G5+ system on smaller samples

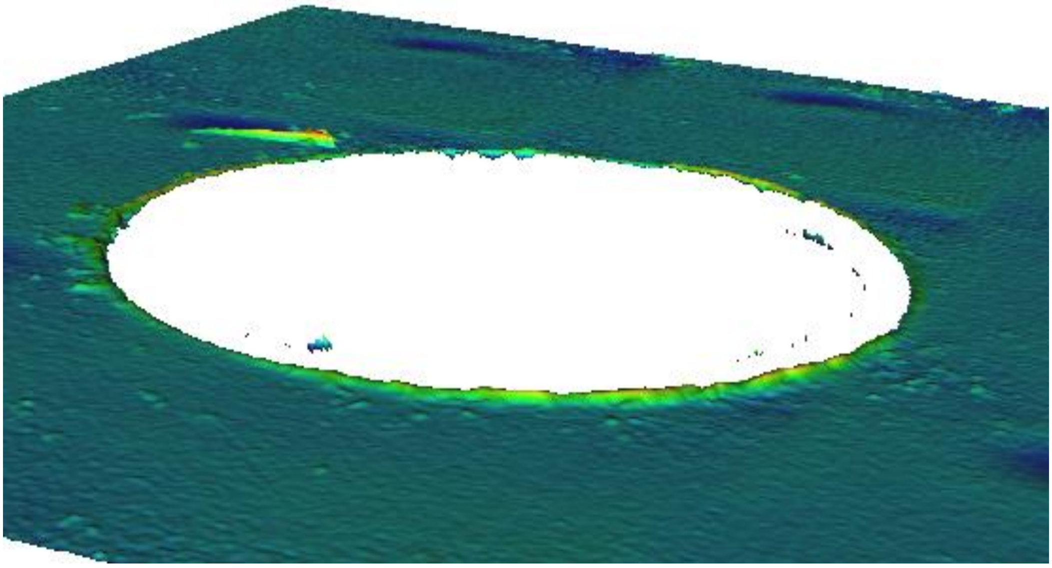
Measurement Task

The measurement task involved inspection of the metallic exit burr of a titanium and CFRP stack, typical of assembly structures used throughout the aerospace industry. A Focus Variation 3D scan of the metallic exit burr around a drilled hole was captured. This allowed both the maximum and mean exit burr around the hole to be quantified and compared to the drilling parameters. Each coupon contained numerous drilled holes and the 'Bruker Alicona script' was therefore used to automate data capture, with the µCMM moving between each hole automatically.

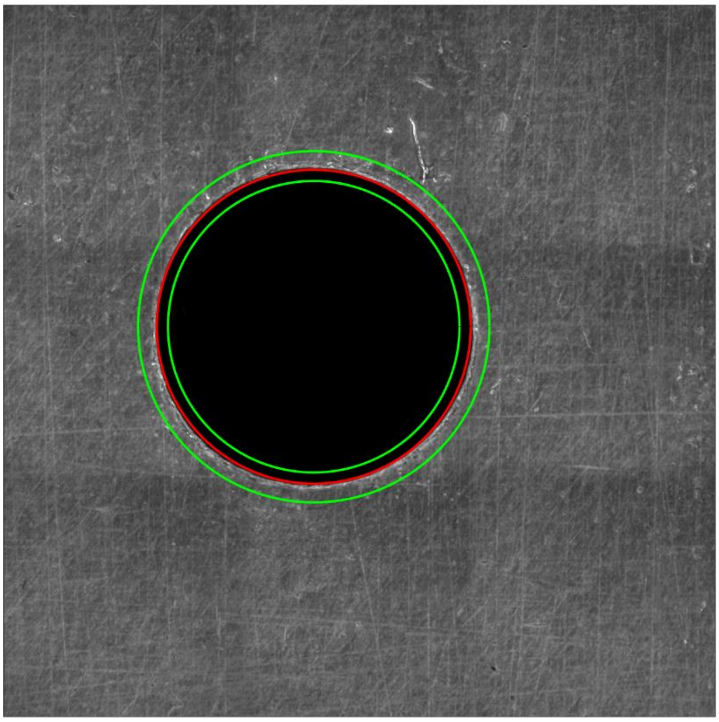
The vertical and horizontal resolution of the Focus Variation 3D scan were set to 3 and 20 µm respectively. The 3000A lens, with a magnification of 2.5336x was used, with optimal light settings found using a ring light. The holes had a nominal diameter of 8 mm, with a total of nine scans stitched together within the ImageField (3 columns x 3 rows).



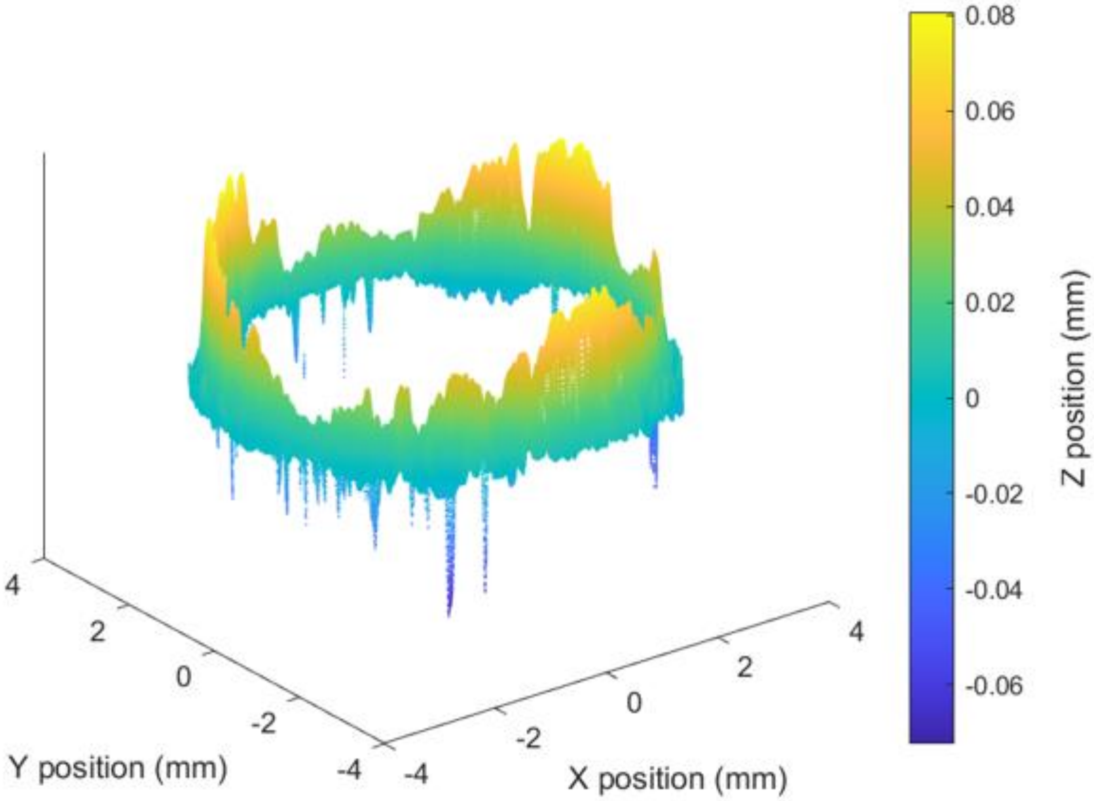
Once data was captured, a qualitative data inspection was performed within Bruker Alicona MeasureSuite software.



Next, a script was used to automatically process the data and identify a region of interest (ROI). In order to find the ROI, the hole location was first identified using standard image processing techniques. This is shown by the red circle in the image below. Next, two circles encompassing the ROI were defined. These are shown by the green circles in the image. The centre of both circles were coincident with the hole centre, with radial offsets set by the user according to a qualitative assessment of burr width.

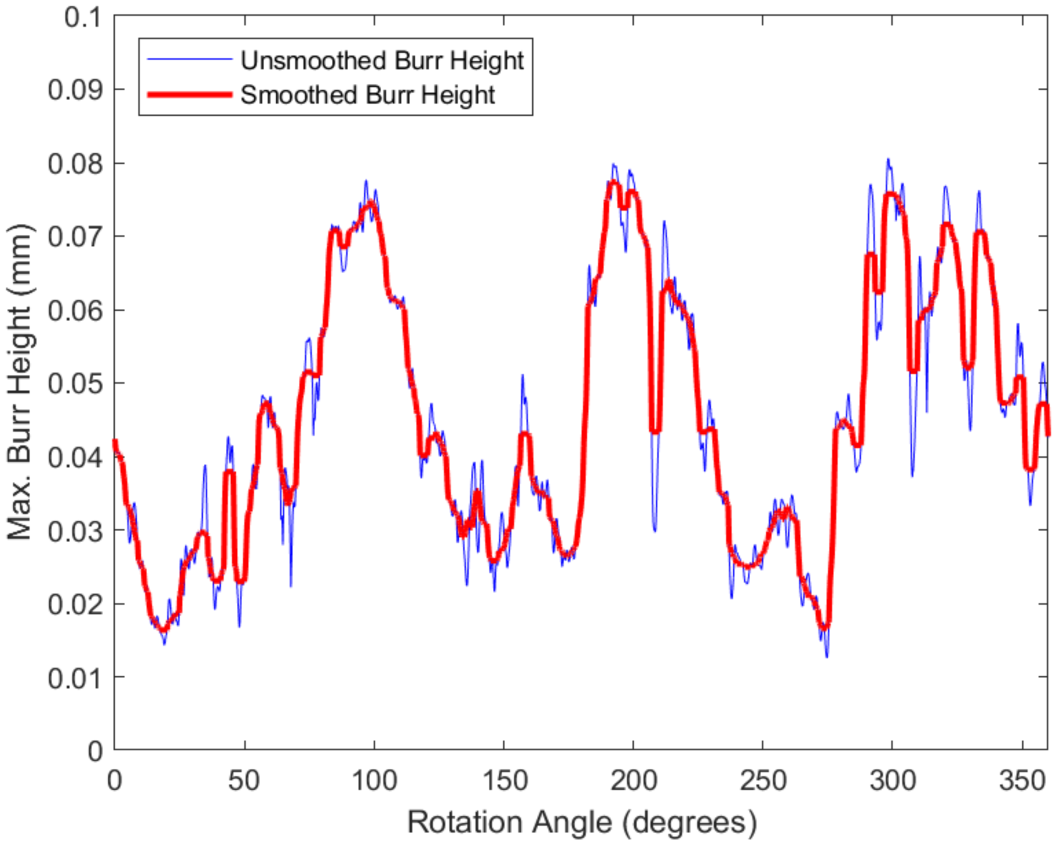


This 3D data from within the region of interest was then plotted in both Matlab in order to visualize the burr.



Finally, the region of interest was converted from a cartesian coordinate system to a polar coordinate system. This allowed the maximum burr height at each rotational angle to be plotted. A median smoothing filter was used in order to remove anomalous points, caused by measurement reflection. A maximum burr height of 77 µm was found. This is within 100 µm which is considered a typical industrial limit. In addition to the maximum burr height, a mean burr height of 45 µm was found.

Sample mounted on an Advanced Real3D unit; this also allows sample to be rotated



Summary

Metallic exit burr is a common problem not only within the aerospace industry, but manufacturing in general. High exit burr often presents safety issues, problems concerning part quality, part assembly and part failure. The high-quality output of the Bruker Alicona µCMM system, coupled with its speed at scanning multiple holes, allowed the AMRC the opportunity to develop a reliable automated method of metallic burr height. Reliable and fast burr height measurement and quantification will assist researchers during numerous research programs focussing on novel CFRP/metallic and metallic hole generation processes.

Further development of this process will investigate evaluation of the distribution of the burr height with respect to distance to the edge of the hole.

Acknowledgments

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Bruker Alicona would like to thank AMRC for preparing this application note and giving permission for its use.

Details on the Bruker Alicona μCMM can be found at http://bit.ly/34ht4tk