ZERO DEFECT MANUFACTURING

Quality Inspection for Fiber Composites

PROFACTOR®

FROM RESEARCH TO PRODUCTION
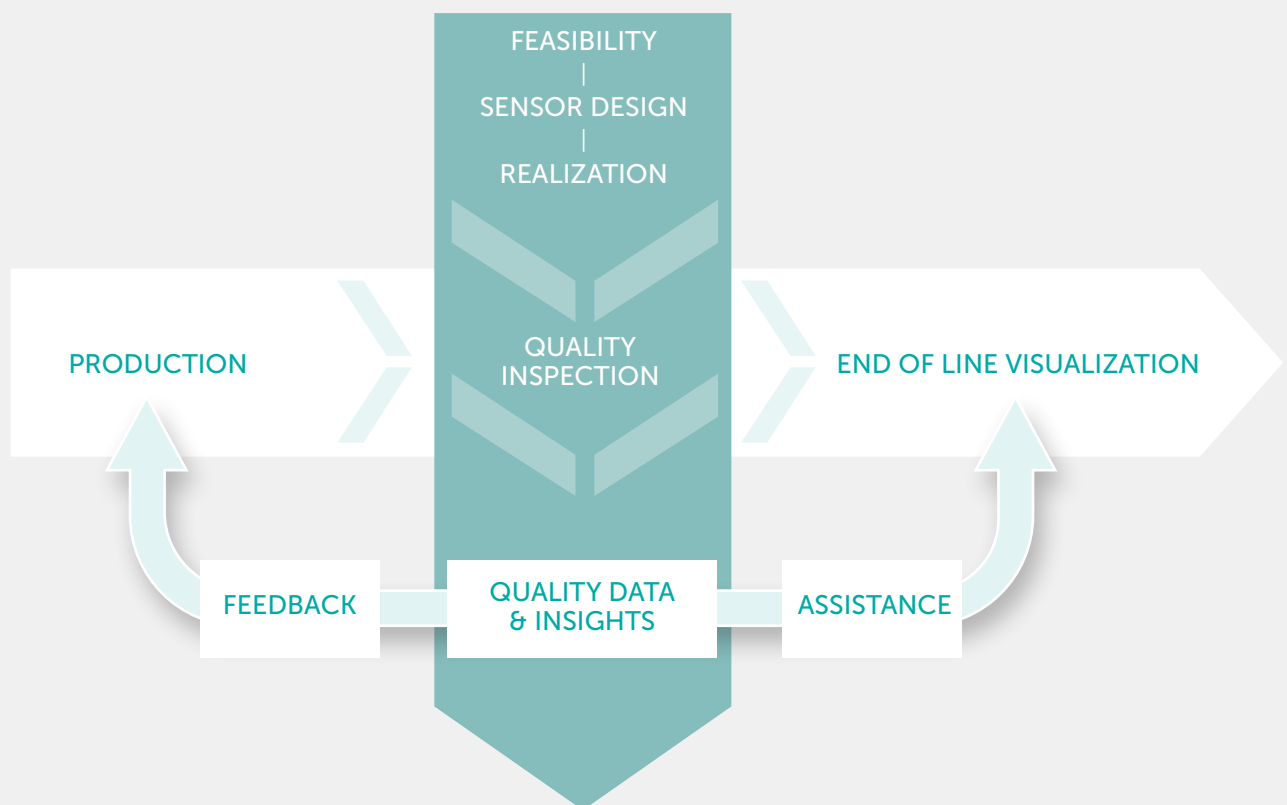
FIBER COMPOSITES INSPECTION SOLUTIONS
Our contribution towards ZERO DEFECT MANUFACTURING

The strive for lower defect rates in manufacturing is getting more and more important. Drivers are not only costs, flexibility, competition or material shortages but also a growing focus on sustainable processes and products. Sorting out defective parts is no longer a path to success.

The complete manufacturing process needs to constantly learn from output quality. Automated surface inspection based on machine vision plays an important role to close this feedback loop. Sensors combined with machine learning are able to cope with a growing variability of both product designs and materials, and are able to learn from human decisions making.

These inspection systems provide quality data which go beyond simple good or bad decisions and hence support the path towards Zero Defect Manufacturing.

FEASIBILITY
|
SENSOR DESIGN
|
REALIZATION

PRODUCTION

QUALITY INSPECTION

END OF LINE VISUALIZATION

FEEDBACK

QUALITY DATA & INSIGHTS

ASSISTANCE

Advanced Inspection Solutions

PROFACTOR inspection solutions offer much more than finding defects.

Our sensors provide powerful insights into manufacturing quality of fiber composite parts and material. Thereby decisions are not only based on predefined parameters but algorithms learn from human decision making. This goes beyond standard measurement solutions and is the basis to bring manufacturing to a next level.

By using quality data provided by our sensors we help you to close the feedback loop to further improve your production processes.

PROFACTOR has 25 years of experience in creating advanced technology to improve industrial manufacturing. With our solutions and expertise, we support your path towards zero defects, better quality and competitiveness.

Quality inspection that goes beyond good/bad decisions

FIBER ORIENTATION MEASUREMENT
Fiber analysis through advanced machine vision (F-SCAN)

Correct fiber orientation is a critical success parameter in carbon and glass fiber composite parts. The growing demand on high-strength and lightweight structural parts in applications such as aerospace, automotive, etc. requires a robust quality control technology to guarantee strength and optical quality of parts. Optical measurement methods are in principle well suited for such automated inspection.

Carbon fiber materials appear either black or shiny bright, depending on the illumination direction. These complex reflection properties therefore pose severe difficulties to standard quality inspection technology based on conventional image processing.

Solution

The F-SCAN inspection system allows an accurate measurement of fiber orientation on carbon and glass composite parts. By using directional illumination and based on an elaborate reflection model PROFACTOR's sensor technology is specifically designed for robust analysis of positions and orientations of fibers. In addition, it allows the automatic detection of typical defects such as inclusions or distorted fabric.

The technology can be used during different stages of the manufacturing process. Starting with the inspection of raw fiber material, the measurement of fiber orientation of the preform part and finally for quality control of the clear-coated part.

F-SCAN Standard

The standard sensor is designed for fast scanning of low curvature fiber composite surfaces.

» Resolution: 40-60μm
» Size of sensor: 200 x 200mm, length: 300mm
» Field of view: 50 x 50 mm
» Measurement speed: 1m/s

F-SCAN Compact

The compact design is smaller in size and therefore well suited for the inspection of parts with high curvature or in confined spaces. It is also better suited for the integration into handling systems for automatic draping and therefore enables inline quality control.

» Resolution: 40-60μm
» Size of sensor: diameter: 84mm, length: 235mm
» Field of view: 25 x 25 mm
» Measurement speed: 1m/s

F-SCAN Wide

For the inspection of fabric a modular version of the sensor is available, which can be extended to a width of e.g. up to 2.5m (100"). This modular design allows its adaptation to any scanning width and can be integrated into weaving machines for inline quality control.

» Resolution: 40-60μm
» Scan width: 2,5m
» Measurement speed: 1m/s

Advantages
» Robust fiber orientation analysis
» Automated measurement on curved parts
» Integration of quality control with draping process (Inline inspection)
» Comparison with draping simulation
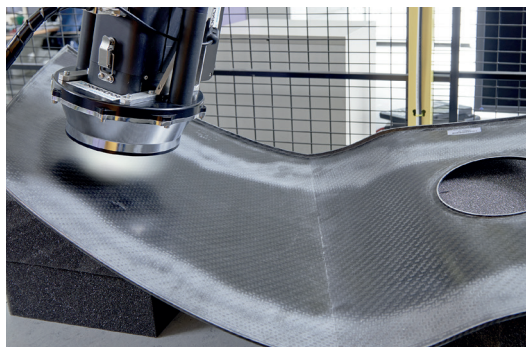
Wide range of materials
» Glass and carbon fabric
» Preforms and parts
» Non-crimp fabric (NFC) and woven materials
» Fabrics with or without sewing yarns
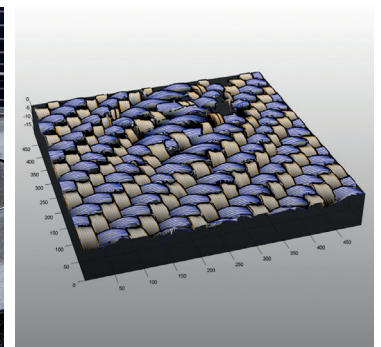» Pre-preg material

Application areas
» Automotive
» Aerospace
» Lightweight construction
» Sports equipment, boat building
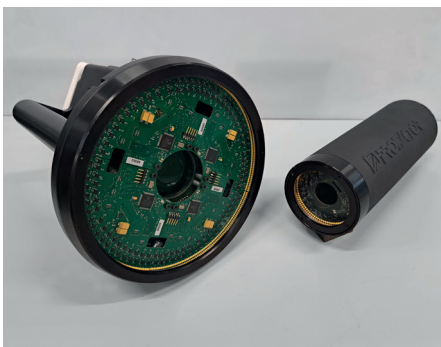
F-SCAN Standard und F-SCAN Compact

F-SCAN sensor scanning a carbon composite part

3D reconstruction of fiber orientation

INLINE QUALITY CONTROL FOR AFP PROCESSES
Realtime feedback on typical defects during fiber placement (L-SCAN)

Automated fiber placement (AFP) is an important process for efficient production of lightweight components for the aircraft industry. Manufacturing structural parts usually requires the placement of many layers of fiber material and takes long hours. For such large parts the manual inspection of each layer is very demanding, but currently necessary to avoid that defects are only detected on the final part.

Solution

The L-SCAN sensor technology is designed to meet the specific requirements of automatic fiber placement processes in the aircraft industry and the manufacturing of pressure vessels. It enables the automated inline inspection of the entire surface of all AFP layers.

Due to an optical design which scatters the laser light, the sensor can cope with the complex reflective properties of carbon fibers. While scanning the surface the sensor provides depth images of the edges of the individual carbon fiber tows.

When integrated with the laying head, the L-SCAN system is able to monitor the tow position and orientation during the placement process. Gaps between tows are checked, typical defects such as overlaps, linting and twisted tows are detected robustly. False alarms are virtually eliminated and defects are reported in real time.

Sensor Specifications

» Sensor size: 320 x 150 x 140mm
» Field of view: 100 x 30mm
» 2D Resolution: 50µm
» Depth resolution: 100µm
» Evaluation time (typical): 360 profiles/sec. (at 100 x 30mm field of view)

Advantages

» Inline quality control for AFP process
» Compact and robust design
» Application-specific modifications are possible
» Robust technology based on long time experience with inspection of fiber composite parts and material
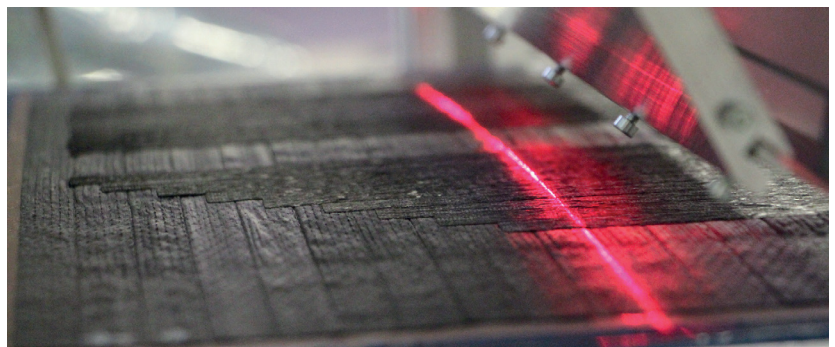
Wide range of materials

» Structural parts
» Uni directional (UD) fiber materials
» Scan width up to 32 tows

Application areas

» Aerospace
» Pressure vessels
» Sports equipment, boat building
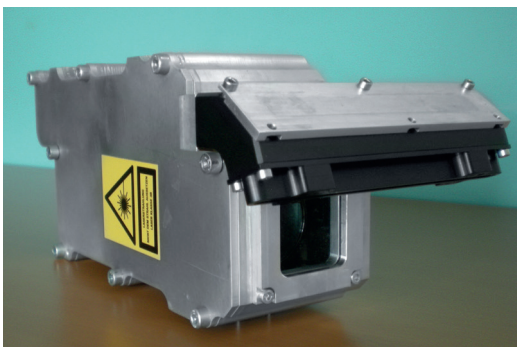
L-SCAN sensor

L-SCAN sensor scanning a layer of fiber tows

QUALITY CONTROL OF HIGH-GLOSS SURFACES
Objective assessment of high-gloss surfaces that matches human perception (D-SCAN)

High-Quality surfaces such as wood veneer play an important role as lightweight decorative parts for the aviation industry. These surfaces are high-gloss lacquered, the quality of which is a critical parameter during acceptance tests of such parts by OEMs.

In conventional quality control procedures measurement instruments are used which provide typical properties such as surface roughness or gloss level, etc. Although these parameters are often within the specified tolerance levels the surfaces do not look good enough to an individual person. The measurement of basic physical parameters is not sufficient to capture the human perception of such glossy surfaces.

Solution

D-SCAN is a proven surface characterization sensor that matches human perception of high-gloss surfaces. The portable sensor is based on a CMOS sensor with integrated data processing and captures a 2-dimensional image instead of just a linear profile. For each application the sensor will be calibrated on a set of sample surfaces that were evaluated by quality control experts.

These manual evaluations are represented in mathematical models which are then the basis for the characterisation of the surface properties and resulting in a single score for good/bad decisions. Therefore, the D-SCAN sensor provides an objective and accurate measurement of high-gloss surfaces.

Sensor Specifications
» Field of view: 50 x 50mm
» Image size: 800x800 pixels
» Resolution: 60μm/Pixel
» Measurement time: 5 sec.

Advantages
» Inspection technology that matches human perception
» Robust and fast quality control through 2D measurement and characterisation based on machine learning
» Improved quality through objective surface inspection and documentation
» Portable sensor, wireless data transmission to PC
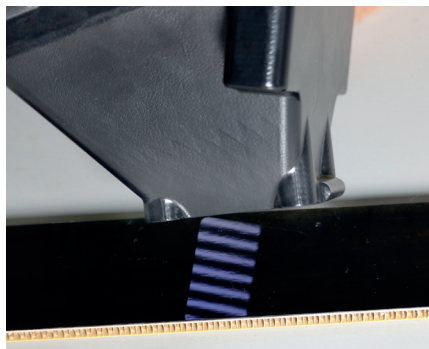
Wide range of parts and materials
» High-gloss interior parts
» Painted decorative components
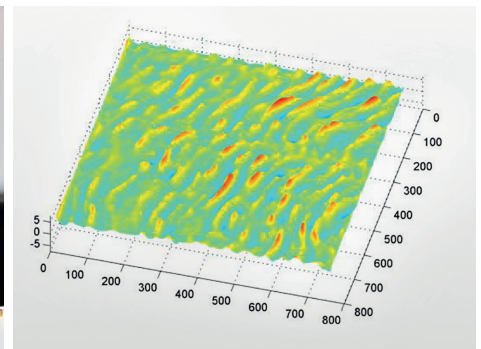» Chrome-plated parts

Application areas
» Automotive
» Aerospace
» Lightweight construction
» Sports equipment, boat building
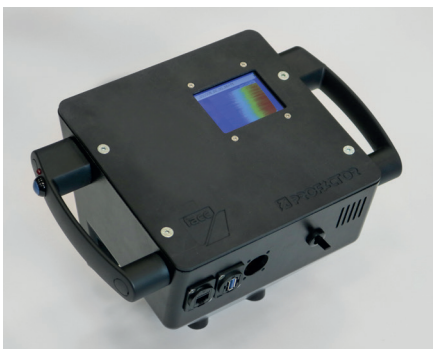
Portable D-SCAN sensor

D-SCAN sensor in action

3D surface topography

QUALITY CONTROL OF STRUCTURED SURFACES
Objective assessment of structured surfaces that matches human perception (T-SCAN)

In interior design of passenger aircrafts structured surfaces are widely used, e.g. on overhead compartments. The standard quality control procedure for such parts is a manual inspection of each surface, which is obviously a highly subjective process.

Conventional systems for surface roughness measurements only provide data on standard roughness and typically only measure along a short straight line. Therefore, they are insufficient to correctly capture the visual appearance of such textured surfaces. Small variations of the surface coarseness that are visible to a human eye are difficult to convert into objective inspection results with these methods.

Solution

The T-SCAN sensor provides a robust inspection solution by capturing a surface area which is sufficiently large (typical 50x50 mm) to obtain an accurate assessment of the surface properties (e.g. reflectance) relevant for human impression.

A series of images are captured using different illumination angles and are combined to obtain values of gloss and coarseness (perceived roughness) of the surface. In a first step, these values are used for a reproducible comparison between different surface textures and the definition of tolerance limits which reflect the visual appearance as perceived by a human quality expert. During measurement, the sensor is capturing the surface in 2D and the algorithm provides an accurate value for the surface properties.

Sensor Specifications

» Field of view: 50 x 50mm
» 3.5" TFT display
» Battery powered (rechargeable)
» Measurement times 1 sec
» Output: gloss, surface coarseness

Advantages

» Reproducible, objective character-
  ization of structured surfaces
» Good match to human perception
» Well defined tolerance limits

Applicable for a wide range of parts, materials and situations

» Automated inspection of structured
  surfaces with light colour
» Spot-checks on surfaces during air
  craft assembly
» Automated scanning during
  production

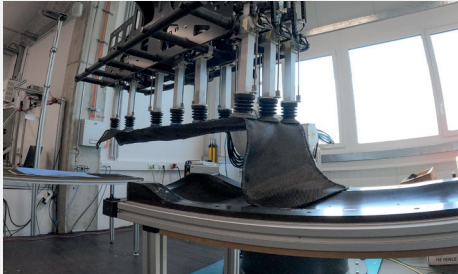### Application areas

» Aerospace interior parts
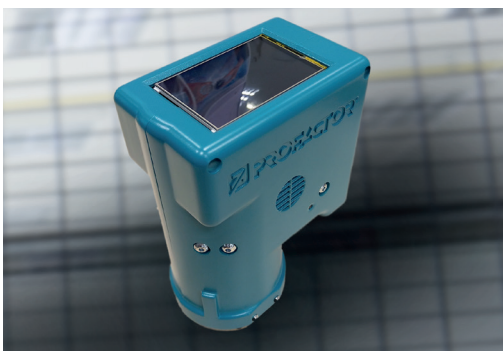
T-SCAN Sensor

T-SCAN testing an airplane overhead compartment
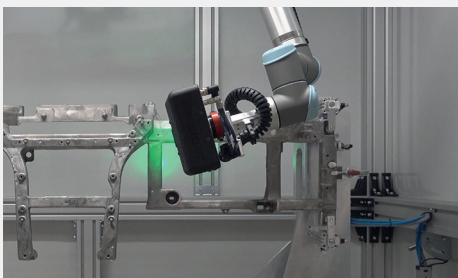
PROFACTOR'S INSPECTION SOLUTIONS
Advanced technology for your path to Zero Defect Manufacturing

Choose PROFACTOR'S INSPECTION SOLUTIONS for


PERFORMANCE

Key success factors of inspection systems are the detection of all relevant defects and the minimization of false rejections. Our inspection systems stand out by a robust characterisation of real defects vs. non-critical variations and learn from human decision making.

FLEXIBILITY

PROFACTOR's solutions have been deployed both in series production lines and in variable production environments. A flexible and robot-based tool designs supports zero tooling time.

The integration of new product designs into the inspection algorithm is simply done by software configuration and hence enables a flexible production planning.
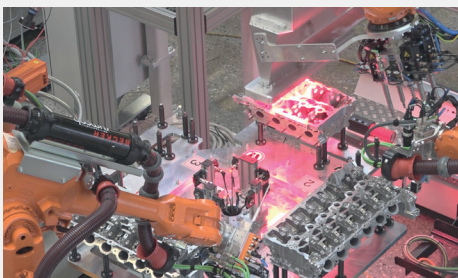
SCALABILITY

No matter how many features you want to inspect on a given part, our solutions are scalable from a few up to hundreds of different defect classes.

Our proven tools for configuration, reporting and archiving can be tailored to your requirements and grow with manufacturing demand.
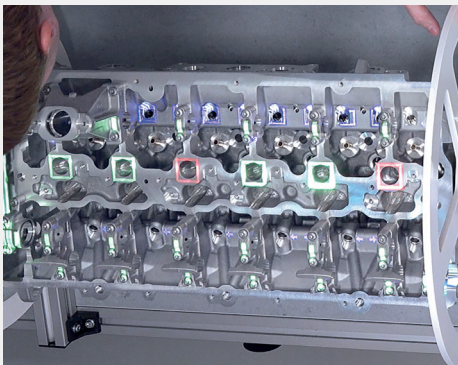
ASSISTANCE & INFORMATION

In many production lines high-value parts need to undergo a manual verification if parts have been classified as process deviation by the inspection system. We offer advanced visualization systems which support your quality experts and allow them to find the detected defects quickly, either by touch screen interaction or through augmented reality projections of defect information right onto the part.

In addition, the system provides accurate information on all detected defects and near defects, condensed into meaningful quality reports with information on types, sizes and location of defects.
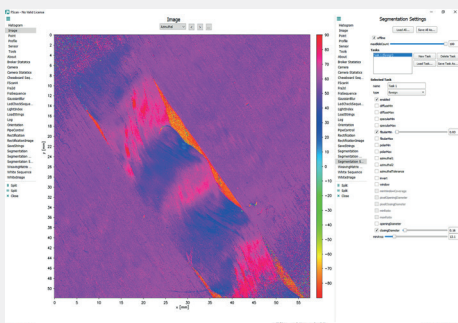
QUALITY DATA ANALYSIS

PROFACTOR supports your journey towards Zero Defect Manufacturing by closing the feedback loop from inspection to production.

Our data analysis software easily processes inspection data from several months while allowing real time interaction. Intelligent data visualisation such as trend graphics, heatmaps of defects or history of defective parts support your understanding of quality statistics and help closing the loop from quality control to production.

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