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1


2

1 *True process optimization requires traceability over the entire value chain. This also applies to mass-produced parts.*
2 *Track & Trace FINGERPRINT relies on the individual surface microstructure as marker.*

TRACK & TRACE BY »FINGERPRINT«

Traceability turns out to be one of the cornerstones of digitalized production – and a major prerequisite for sustainable production and perfect documentation. Only unambiguous identification enables data acquired during the production process to be attributed to individual components or semi-finished products. Track & Trace FINGERPRINT, a novel tracking and trace procedure for mass-produced parts by Fraunhofer IPM, is the first traceability system to utilize a component's individual surface microstructure as a distinctive feature for tracking. A characteristic bit sequence is generated for each component on the basis of its individual surface microstructure, with no need for additional markers.

Tracking components down to the last screw

The quality of complex industrial products may depend on the quality of each and every component. For example, a single faulty connector, even if it is worth only a few cents, may impair the performance and durability of a complex electronic control box in a car. As a consequence, if an assembled component fails its performance test, all the semi-finished parts already fitted are »guilty by association« and the entire potentially defective batch is rejected. This results in companies incurring high costs, often without learning any lessons for optimizing their production processes.

Consistency in digitized production

The aim must therefore be to provide even the smallest of component and semi-finished product with an individual ID signature so that they can be traced along the production chain, preferably from the outset. This is the only way of rectifying recurring production errors detected by in-process inspection systems. Seamless traceability by far exceeds the boundaries of a company's own production and enables to identify

Track & Trace FINGERPRINT

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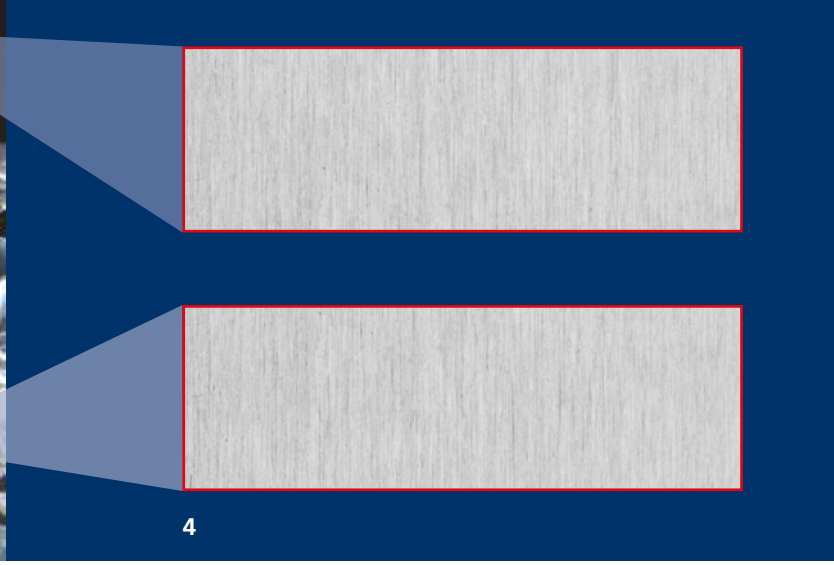
3



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sources of error during production along the entire supply chain.

Traceability at reasonable cost

There is one thing that the process of tracing mass-produced parts must not be: expensive. Many established marking methods fail at this first hurdle because they require additional costly production steps such labelling with RFID or data matrix codes. By making use of the existing individual surface structure, Track & Trace FINGERPRINT does not incur additional costs per unit and does not affect any component functions as most common marking methods do. It is not wise for manufacturers to engrave serial numbers on sealing surfaces or place barcodes on decorative items. Furthermore, while some components are simply too small to be marked, those that can be are at risk of having their markers counterfeited. None of these problems apply to the label-free Track & Trace FINGERPRINT procedure, because it makes use of the existing surface structure of components.

Even mass-produced parts are unique

On closer inspection, almost all technical surfaces reveal incidental characteristics like microstructures or interwoven colors that clearly identify the component in question. Track & Trace FINGERPRINT uses a specially developed optical reader to take high-resolution images of defined areas on the component's surface. The specific structural patterns captured by the image and the way in which they are positioned relative to each other is used to generate the fingerprint code, which is then stored in a database, combined with an individual ID. This process can be repeated to identify the component at a later date by taking an image of the very same component area and generating a fingerprint code. If matching this fingerprint code to the existing database entries generates a match, the component is clearly identified by the respective ID. This allows attributing additional information such as measurement or production data to any individual component. Track & Trace FINGERPRINT has been designed to enable different component sizes and geometries and a wide range of materials, from plastics to precision-machined aluminum, cast iron and varnished surfaces, to be identified in line with the rate of production using the same hardware.

Identification without delay

Taking an image of the surface structure and generating the fingerprint must not delay the production process. Track & Trace FINGERPRINT relies on a fast camera-based sensor system as reading device which records high resolution images of the surface microstructure with a CMOS image sensor. Based on these images, the fingerprint of each individual component is generated by means of a special algorithm. Reducing the image data to a simple bit sequence with low memory capacity need enables data matching in line with the rate of production. Tolerances when positioning the components are compensated by software on the basis of suitable geometric reference points. Possible interferences such as impurities or scratches on a component's surface are eliminated by redundant information transfer . Interfaces to database systems are adapted according to customers' need.

Optimizing production processes

Consistent traceability without markers throughout the entire production process creates substantial added value. This is especially true for branches like automotive or medical technology where high quality standards prevail. Large amounts of measurement and process data, which can be attributed to individual components, open up the possibility of optimizing production processes.

3 *Even surfaces of very small punched parts can be used for label-free component identification.*
4 *Characteristic incidental micro structures identify each individual part. As part of the Track & Trace FINGERPRINT procedure, they are reduced to a simple bit sequence.*