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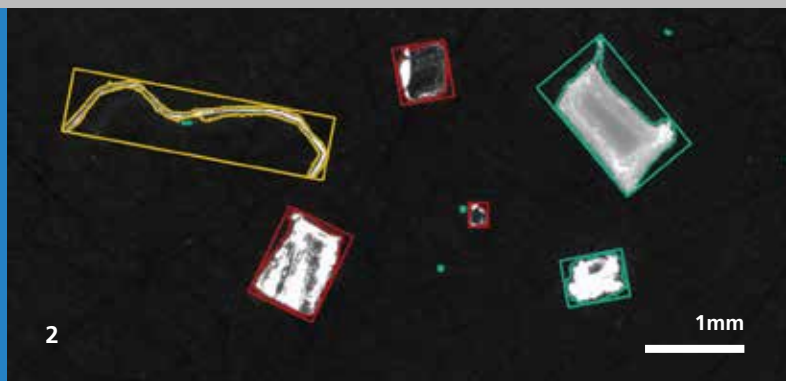


1 *Even single particulate impurities can lead to component failure. Therefore, measurement and classification of particles directly on the critical component surfaces is required.*

2 *By combining different imaging techniques, the particles are detected directly on the component and classified according to the VDA19 standard by size and type: metallic (red), non-metallic (green), fiber (yellow).*

# INLINE PARTICLE DETECTOR

## IMAGING DETECTION AND CLASSIFICATION OF PARTICULATE CONTAMINATION

Technical cleanliness is a decisive criterion for the service life of highly stressed components. Contamination even by small metal particles may prove critical. One single particle can lead to the failure of an entire component assembly. However, the question of whether a component is clean enough for the next production step cannot be answered satisfactorily in the line. Today, the standard analysis according to VDA 19, a standard for the cleanliness of products defined by the German Association of the Automotive Industry, which involves a washing step and a subsequent analysis of the filtered washing medium, is carried out on a random sample basis. The inline particle detector by Fraunhofer IPM for the first time enables cleanliness control in the line. The system detects particulate impurities on the component non-contacting and evaluates them. Complex extraction procedures are no longer necessary and the results are available in real-time. If the quantity of impurities exceeds a defined threshold value, the component is sorted out or cleaned again and reintroduced into the production process.

### Quantitative 100 percent control

The Fraunhofer IPM inline particle detector enables 100 percent purity control directly

The inline particle detector provides both images and quantitative measurements of the shape, position or amount of contaminants. In this way, spatially resolved evaluation helps to optimize production processes. The results can also be stored in the customer's own QM system to document quality characteristics. This enables the documentation of surface cleanliness along the entire process chain – along with all suppliers.

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3 *On structured surfaces, particles are often difficult to detect optically (left). However, if a second image of the same surface is recorded after the position of possible particles has been changed by applying compressed air (center), a difference image clearly reveals the particles (right) so that they can be reliably removed.*

## Tailor-made system concepts

The optics and illumination of the inline particle detector are housed in a miniaturized measuring head that can be traversed over the component by a robot arm. The measuring head can be adapted to the respective component geometry so that even components with complex 3D geometries can be inspected.

Figure 1 shows an example of the implementation of the system for the inspection of cylinder bores of a combustion engine. With such a system, particles can be reliably classified according to type and size. The data collected in this way can be used in a user-friendly manner via the software interfaces provided, e.g. for controlling the production process or for displaying and storing the results in existing quality documentation systems.

## Classification of particulate impurities directly on the component

In addition to the determination of particle size, classification by particle type is essential for genuine quality assurance. For this purpose, different imaging methods are combined in one system (Fig. 2). As with the VDA 19 standard analysis, the particle detector makes use of the fact that, under sophisticated illumination, metallic particles exhibit a characteristic gloss typical for the material. Using image processing, critical metal particles can thus be distinguished from non-critical fibers or non-metallic particles. Depending on the particle class, different threshold values can be specified in the system.

## Reliable detection even on distinctly structured components

On distinctly structured components, the detection of particles by means of imaging is often challenging. Based on extensive system competence, Fraunhofer IPM adapts the imaging technology to almost any task. Figure 3 shows an example of an innovative method that enables the detection of particles even on assembled circuit boards and similarly complex components. In an ordinary picture (left), particles are almost indistinguishable from the component structures. In order to detect the particles, it is exploited that the particles are not or only slightly bound to the component. By applying a pneumatic pulse, their position changes, which is captured in a second image (center). The difference image (right), finally reveals the particle in high contrast.

### Typical system specifications

| | |
|---|---|
| Field of vision | 19 x 14 mm² |
| Pixel resolution | 5 µm |
| Detection speed | 0,1 s / image |
| Classification of particle size | 20 µm – 2 mm |
| Classification of particle type | Metallic, non-metallic, fiber |

*All specifications and features are subject to modification without notice.*