Safe and Simple Component Cleanliness

Detect, Identify, and Eliminate Particle Sources

In more and more areas, the exact knowledge of particle contamination is gaining in importance. Until a few years ago, contamination of materials in dimensions of a few micrometers was mainly of concern for the pharmaceutical and semiconductor industries. However, as miniaturization progresses and demands on modern quality assurance and production methods increase, microparticles are causing problems in more and more areas. Not only manufacturers of plants for circuit board production, but also classical car suppliers face new demands on particle recognition and contamination source identification. To make a simple tool available to all users, the integrated system solution Particle Explorer was developed. This system combines all separate steps, from particle isolation in the production environment to automated on-site material identification. For the first time, all users are thus able to detect a contamination and, through material identification, trace its source to eliminate it as quickly as possible.

Capture, Find, and Monitor Particles

The patented filtr.AID Membrane and the filtration set allow simple particle capturing (Fig. 1).

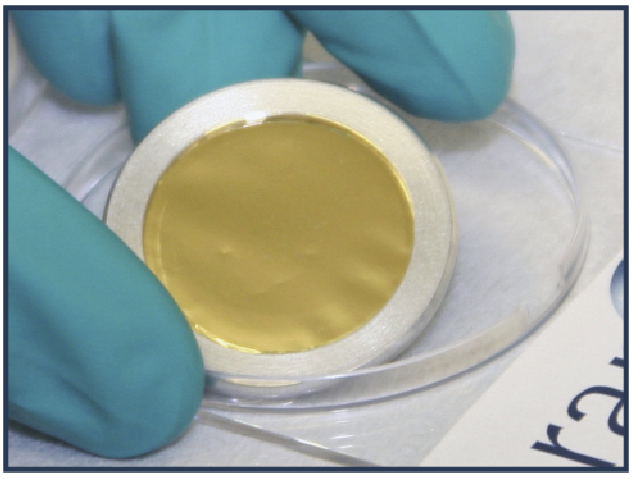


Fig. 1: fitr.AID Membrane in Petri Slide. Gold-plated, aluminum-mounted polycarbonate membrane.

Liquids or gases are passed through a membrane, particles of up to 200µm in size remain on the membrane surface and stay intact even when transported in a letter. A special particle-free glue (fix.AID) ensures that larger particles stay fixed to the membrane. The gold-vaporized membranes are available with nuclear pores between 0.2-20µm. The nuclear pore size is chosen depending on the viscosity of the medium and the size of the particle to be analyzed. The membrane is mounted in an aluminum ring to

ensure that the effective filtration area (EFA) – which holds the particles - is always centered. The aluminum ring frame and the provided Petri slide allow easy handling and archiving for the user.

Once the particles are reliably filtered on the membrane, Particle Finder® can count and classify them. At the touch of a button, the membrane is centered and tightened by the sample unit. Specifically designed for filtr.AID membranes, this sample unit eliminates the problem of refocusing after each sample change (see Fig. 2). A specially constructed darkfield unit illuminates the particles on the membrane with optimum contrast.

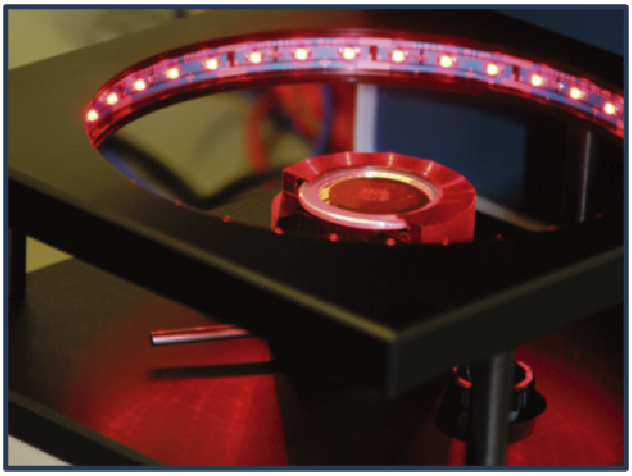


Fig. 2: Sample unit with darkfield illumination.

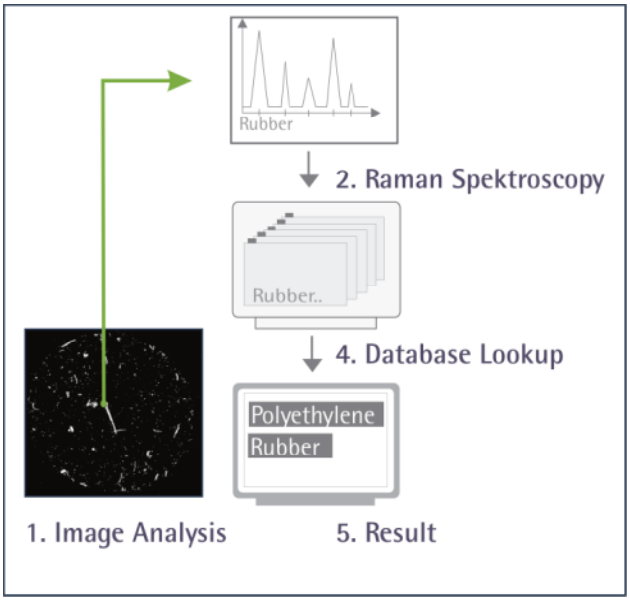
Fully-automated image analysis software determines the particle size distribution from the microscopic image of the area. Within a few minutes after sample insertion, the size, number, and shape of each individual particle are entered into an automatically-generated table in compliance with standards ISO 16232 and VDA Vol. 19 (see Table 1). If collected over a longer period, this data can also serve for trend analysis and, thus, for the derivation of threshold values for critical process steps. The temporal variation of particle contamination levels itself provides information on possible contamination sources, the effectiveness of cleaning cycles or the consequences of changes in personnel.

Micro-contamination - Identification and Elimination

Exceeding of limit conditions often entail the analysis of causes. The cause analysis of exceeded specification values is facilitated through the connected material identification of the particles. The particle identification systems of the Particle Explorer® series allow automatic identification of any particle on the membrane. This is achieved through fully-automated integrated Raman spectroscopy.

This method comprises several automated processing steps: First, a microscope positions and focuses a laser beam on the respective particle. At optimum focus, the measuring spot has a diameter of approx. 1µm. The laser light enters about 2-4µm deep into the matter. At this depth, the material interacts with the light: While most of the photons of the monochromatic laser light wave leave the substance unchanged and with no information on the particle, 1 photon out of 1.000.000 changes its color

due to its interaction with the particle. A detector monitors these changes which – processed as spectra – provide specific information about the molecular particle structure. Since the spectrum of a substance is as characteristic as a fingerprint, spectral comparison allows exact and reliable determination of the material composition. Although Raman spectroscopy provides the same information as the better-known infrared spectroscopy, it also allows the analysis of particles 50 times smaller. With Raman it is now possible to identify, particles of a few hundred nanometers in diameter.



With exacting reliability, the spectra obtained this way are compared with those in the database, and the result is then presented as size, number and name of the substance, e.g., cotton fiber, rubber, talcum or sand particle (Table 1).

Tab.1: Particle Size and Substance distribution

Substance	50-100 µm	100-150µm	150-200µm
Rubber	25	5	0
Paper	56	24	5
Polyethylene	186	76	21
Cellulose	560	125	54
Not Classified	12	3	1
Total	**267**	**105**	**26**

Any substances, organic or inorganic, can be recognized, with the one exception of laser light-reflecting metallic particles, which cannot be focused on directly. The Raman spectroscopy results therefore complement the established EDX (Electron Diffraction X-Ray) analysis, which provides information primarily about the distribution of the elements in a sample, but not about the more than 10 millions of inorganic substances. The filtr.AID Membrane is just perfect for scanning electron microscope examination. The combination of the two complementary methods in the analysis of the same sample allows access to all physically achievable information for particle characterization.

Isolation and Elimination of Particle Sources

The Particle Explorer allows the user the fast and standardized material identification of soil or contaminant particles in statistically relevant numbers. The fast counting, complemented by the automated particle identification, makes it

possible to localize contamination sources after – or, ideally, before specifications are exceeded.

The exact classification of contamination sources finally allows costly decisions to be made on a scientific basis. The main source of contamination is quickly narrowed down, and even if the comparison with the existing database entries does not exactly identify the source, suspicious material samples can be easily integrated into the database with just a few mouse clicks. In this way, exact matches facilitate, for example, the decision to change the materials for packaging or component storage. In the future, it will be easier to satisfy and document the customers' ever-increasing demands on component cleanliness, and the increased process knowledge creates the long-lasting effect of higher quality and yield.

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