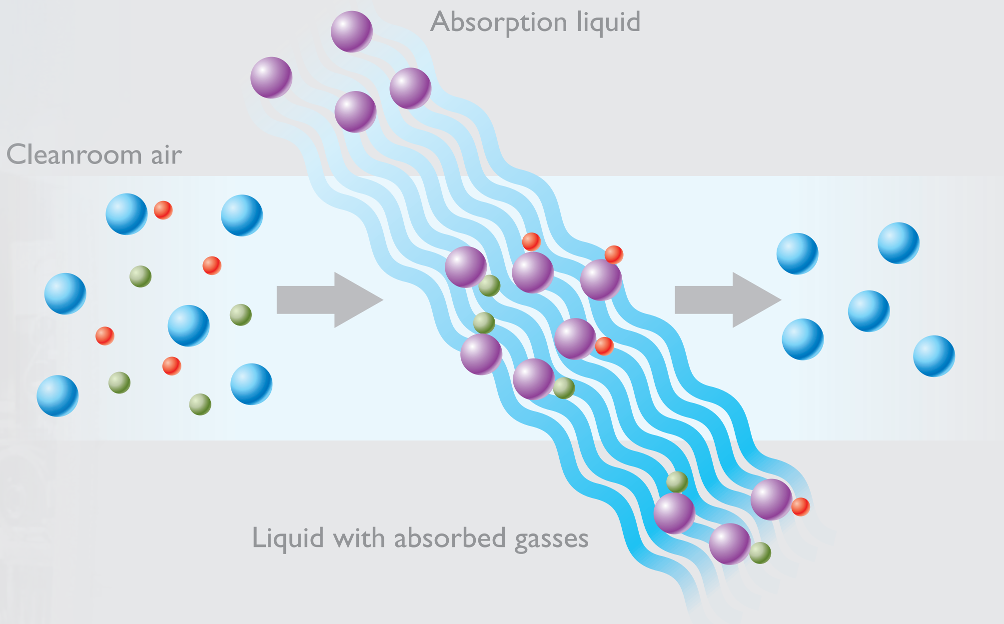

Air pollution in cleanrooms

A closer look with Ion Chromatography

In cleanrooms various processes take place, such as lithography, baking and etching. These activities, but also outside air, can be the source of many gaseous contaminants. These form a potential health risk for people working in the cleanroom. By maintaining normal precautions in the cleanroom, health risks can be avoided effectively as concentrations of contaminants remain far below the MAC values. However, the contaminant level is not zero and the low concentrations present can still damage equipment and influence processes in the cleanroom.This application note describes the analytical method used for the detection of reactive contaminants, like ammonia and acid vapours.

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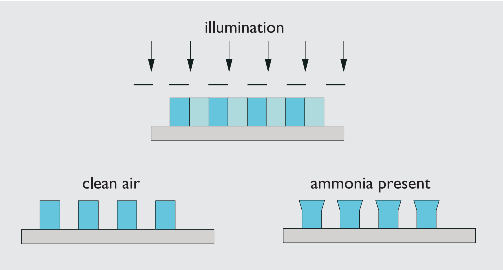

Fig. 1: Photoresists used in deep-UV lithography are very sensitive towards basic compounds. Small amounts of ammonia in the air of a cleanroom can distort the fine details of the image after development.

Basic vapours like amines and in particular **ammonia** (NH_3) are a problem in the fabrication of integrated circuits. Outside air normally has an NH_3 concentration below 10 μg/m^3, but it can be much higher depending on the amount of agriculture in the area. Concentrations higher than 100 μg/m^3 frequently occur. Since most filters do not remove NH_3, such concentrations can be present in the cleanroom as well. The maximum allowed level of NH_3 and amines in many cleanrooms with deep-UV processes is specified at < 1 μg/m^3. This is to protect the photo-resist against distortion of fine details after development (see fig. 1). Special filters can be introduced in (parts of) the cleanroom to lower the NH_3 concentration. Analysis of NH_3 at very low levels is essential to determine whether the specified conditions are met.

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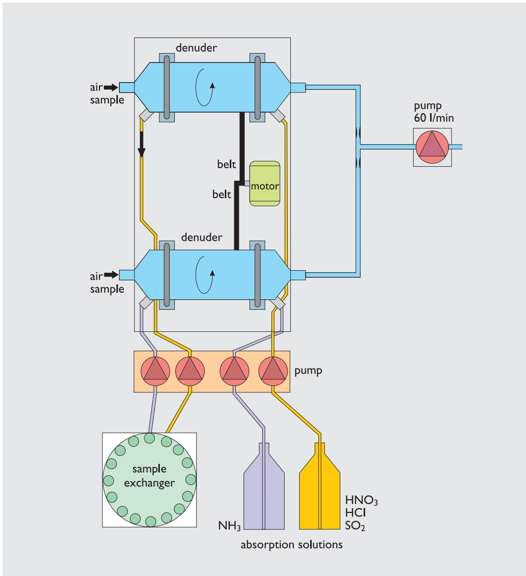
products and equipment. Again special precautions, such as the installation of filters, are taken to prevent these problems. Analysis of cleanroom air is essential to see whether these filters are still effective.

Analysis of reactive gasses

By absorption of the reactive gasses in a suitable solution, simple ions are formed that can be analysed with ion-chromatography. Because of the extremely low concentrations involved, a denuder is used for high efficiency absorption of the gasses (see fig. 2).

A denuder is a device that is designed for sampling atmospheric gasses like NH_3, HCl, HNO_3, HNO_2 and SO_2. The air to be analyzed is pumped through a rotating tube, which is filled with a thin layer of

Fig. 2: Schematic of a denuder.



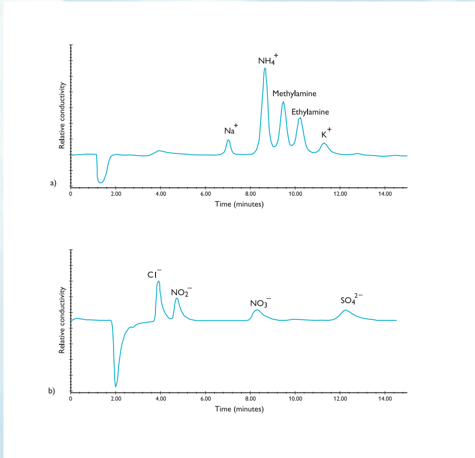


Fig. 3: Typical chromatogram obtained for basic (a) and acid (b) vapours.

absorption liquid. Which liquid is used, depends on which component you want to absorb. The gasses are absorbed in the liquid layer, while particles pass the denuder. After a specified sampling time, which is usually between 30 and 60 minutes, the liquid is pumped to a sample exchanger. As the denuder system consists of two parallel sampling units, NH_3 and acid vapours can be sampled simultaneously.

The absorption liquid can be analyzed using ion-chromatography. The sample is introduced in a mobile phase and pumped through an ion-exchange column. The ions are separated in accordance to their affinity towards the ion-exchange material. Detection is based on conductivity. Depending on the sampling time a detection limit of 0.1 μg/m^3 is obtainable for clean-room air. Chromatograms for both anions and cations in cleanroom air are given in fig. 3.

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