



Ammonia sensors and their applications—a review

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Abstract

Many scientific papers have been written concerning gas sensors for different sensor applications using several sensing principles. This review focuses on sensors and sensor systems for gaseous ammonia. Apart from its natural origin, there are many sources of ammonia, like the chemical industry or intensive life-stock. The survey that we present here treats different application areas for ammonia sensors or measurement systems and different techniques available for making selective ammonia sensing devices. When very low concentrations are to be measured, e.g. less than 2 ppb for environmental monitoring and 50 ppb for diagnostic breath analysis, solid-state ammonia sensors are not sensitive enough. In addition, they lack the required selectivity to other gasses that are often available in much higher concentrations. Optical methods that make use of lasers are often expensive and large. Indirect measurement principles have been described in literature that seems very suited as ammonia sensing devices. Such systems are suited for miniaturization and integration to make them suitable for measuring in the small gas volumes that are normally available in medical applications like diagnostic breath analysis equipment.

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1. Introduction

Thousands of articles have been published that deal with some sort of gas sensor. This makes it virtually impossible to write a review article, completely covering this area. When looking in the scientific literature, summarizing articles can be found that deal with specific application areas or specific types of gas sensors. Examples of review articles about applications for gas sensors are: high volume control of combustibles in the chemical industry [1], exhaust gas sensors for emission control in automotive applications [2,3] or monitoring of dairy products for the food industry [4]. Articles that emphasize a specific type of gas sensor are written about, for example, solid state gas sensors [5], conducting polymer gas sensors using e.g. polyaniline [6], mixed oxide gas sensors [7], amperometric gas sensors [8], catalytic field-effect de-

vices [9] or gas sensor arrays used in electronic noses [4,10]. The review presented here will focus on one specific gas, ammonia.

After a brief introduction of the origin of ammonia in the earth's atmosphere, we consider various artificial sources of ammonia in the air, such as intensive life-stock with the decomposition process of manure, or the chemical industry for the production of fertilizers and for refrigeration systems. Subsequently, different application areas for gaseous ammonia analyzers are investigated with a summary of the ammonia concentration levels of interest to these different areas. Applications in the agricultural and industrial chemistry areas are discussed, as well as environmental, automotive and medical applications for ammonia sensing devices. The overview of application areas provides us with an indication of the required specifications, like detection limits and response time, which will be used as a guideline for the consideration of different measuring principles and techniques, as discussed in the next section.

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