Abstract

In the present PhD thesis three methods for the optical detection of biogenic amines (BA) are presented.

The first system is based on the optical detection of BA in an alkaline medium with the use of o-phthaldialdehyde (OPA) as an indicator dye. The analysis of the optical signal was based on fluorescence measurements. The monitoring system was evaluated with regard to spectral characteristics, effect of the OPA concentration, effect of pH, the response time (t_{95}) and the effect of interferences. It was shown that among the various tested biogenic amines, the OPA was the most sensitive to agmatine (AgmS); namely, the emission intensity of OPA-AgmS fluorescent product was about 14 times higher compared to OPA in the presence of other biogenic amines. The detection limit (LOD) was 2.5×10^{-7} M of AgmS, and the optimal response time was 20 min.

In the second part silica SiO_2-SH particles were synthesized via the Stöber method under alkaline conditions based on the alkoxide precursors tetraethoxysilane (TEOS) and mercaptopropyl-trimethoxysilane (MPTMS). The particles were characterized based on the transmission and scanning electron microscopy. The success of binding of mercapto (–SH) groups was confirmed by FT-IR analysis, whereas the potentiometric titration provided the information on the amount of –SH, as well as on the amount of silanol (Si–OH) groups. The SiO_2-SH particles, with the molar ratio between the two precursors (*P*) TEOS : MPTMS = 2:1, were used as the basis for the bonding of OPA indicator. SiO_2-SH-OPA particles were tested in the presence of various biogenic amines via fluorescence measurements. In this case, we studied the spectral characteristics, the effect of pH and the sensitivity to other biogenic amines. SiO_2-SH-OPA particles showed the highest fluorescence signal change in the presence of AgmS, with a limit of detection of 7.3×10^{-7} M and a response time of 2 min.

The third optical detection method is based on the SiO_2 thin layers, which served as carriers for the chromogenic indicator dye ETH4001 and which enabled continuous detection of biogenic amines via absorption measurements. Sensor membranes were prepared by the acid-catalyzed sol-gel process based on the combinations of tetraalkoxysilane (TEOS) and ormosil precursors (propyl-trimethoxysilane (p-TriMOS) and 3,3,3-trifluoropropyl-trimethoxysilane (F-TriMOS)). It turned out that the detection of biogenic amines was successful only with sensor membranes prepared with a combination of both ormosil precursors, i.e. p-TriMOS : F-TriMOS in molar ratios *P* = 2:1, 1:1 and 1:2. In the presence of isopentylamine, propylamine and putrescine sensor membranes showed similar spectral properties with small differences in the maximum absorption peaks, depending on the type of biogenic amine. When monitoring the BA in the alkaline medium with the afore-mentioned sensor membranes the lowest achieved concentration range was in the presence of isopentylamine, namely in the range of 6.0×10^{-4} M – 1.2×10^{-1} M. These levels are too high, however, making such sensor membranes inappropriate. Anyhow, the optimal response time of the sensors differed depending on the type of the sensor layer and the type of the tested biogenic amine; it ranged between 3 and 20 min, whereas the regeneration time was between 6 and 30 min.

Key words: biogenic amines, o-phthaldialdehyde, fluorescence, SiO_2-SH particles, SiO_2 sensor membranes, ETH4001, absorption.