Smart Hydrogels with Functionality in Gaseous Environments

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Background:

Smart hydrogels are three-dimensional polymer networks which can undergo a volume phase transition in response to an external stimulus, e.g. change of temperature, ion concentration or pH. Furthermore, smart hydrogels can be tailored to respond to bioanalytes such as glucose or thrombin. This ability to adjust them for desired target analytes in combination with the potential biocompatibility and high versatility with respect to composition makes smart hydrogels interesting candidates for biomedical sensing [1].

State of the art and previous work:

Currently, hydrogels are usually used as sensing elements within liquid environments as the gel's response is based on the intake/release of liquid. Furthermore, they have been studied as humidity sensors [2,3]. In that regard, it was furthermore shown that hydrogels can even be used in their dried-out state to detect moisture [4].

Volatile organic compounds (VOC) are of high interest for biomedical applications as they allow to monitor a person's health and to detect diseases at a very early stage in a non-invasive manner [5]. Currently, a variety of approaches is being investigated for different analytes and diseases such as Parkinson's and cancer [5-7]. The challenge in all cases is to detect potentially low concentrations of the target analyte with high specifity.

Scientific Questions and Project Aims:

However, so far, there has only been minimal effort in the direction of employing smart hydrogels for biomedical analyte detection in gaseous environments. It is therefore the aim of this project to explore this possibility, thereby expanding the application range of smart hydrogels.

A study of smart hydrogels for VOC sensing in a gaseous environment would comprise the following tasks:

- Study of suitable conditions (temperature, humidity etc.) under which the smart hydrogel exhibits a strong response for a target analyte in gaseous environments. The parameter range should include the conditions of exhaled breath. For this investigation, a suitable test analyte has to be identified by literature study (e.g. [8, 9]).
- Development of a sensor embodiment which provides the necessary conditions (see first task) and allows unobstructed interaction with the target analyte.
- Identification of target analytes of interest (with biomedical relevance) and tailoring of the smart hydrogel for that analyte (direct or indirect detection).
- Investigation of cross-sensitivities and suitable mitigation structures (and necessity thereof).
- Study of detection limits.

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