

Properties of Polypyrrole Films and their Optimization for  
Possible Enzyme Immobilization

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During the last two decades large-scale studies on conjugated polymers have been revealed their attractive properties, which can be utilized in numerous practical applications. The most specific character of these materials is their electronic conductance, which is connected to that an electrically charged deposit is produced during the polymerization. As a consequence, this property makes it possible to immobilize different substances in the film during its preparation. Enzymes, which readily denature during their adsorption on metal surfaces, may rather be incorporated into polymeric films, where the organic film may serve as a more natural surrounding for the peptides, resulting in the preservation of the special biocatalytic effect. The composite layer may function as an enzymatic electrode, at which the chemical signal is converted to an electric one.

Our enzyme immobilization concept was based on the possibility that the positively charged film could interact electrostatically with the macromolecule. This interaction can be insured by a partial negative charge of the enzyme. Amfoteric materials may have a net negative charge at pH values larger than their isoelectric point,

when the result of the dominant acidic dissociation is the anionic behavior, and the enzyme may contribute to the charge compensation of the film as a 'dopant'.

The aim of this work was to optimize the electropolymerization of pyrrole from two points of view: i) polymerization in non-acidic solution (the pH should be above the isoelectric point) and ii) the structure of the incorporating layer has to insure the transport of the substrate within the film.

The polymerization was achieved from aqueous pyrrole solution containing different anions (such as Cl<sup>-</sup>, B<sub>4</sub>O<sub>7</sub><sup>2-</sup>, PO<sub>4</sub><sup>3-</sup>, DS<sup>-</sup>).

On the basis of in situ spectroelectrochemical, as well as ex situ FTIR and impedance measurements it has been found that an optimal behavior of the film could be obtained with a film prepared in the presence of a large, immobilizing anion such as DS<sup>-</sup>. The properties and perhaps also the structure of the polymeric layer could be influenced even after the electrodeposition: the extent of the conversion into the quasi-metallic state of the pristine film right after the polymerization played a key role in determining the final behavior of the layer.

Studies are in progress to apply the concept and the method for the immobilization of oxidase and hydrogenase enzymes.

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