Oxygen Electroreduction on Glassy Carbon Electrodes Chemically Modified With Dyestuffs Classified In the Oeko-Tex 100 Standard

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Oxygen reduction owns wide applications in electrochemical research fields such as fuel cell and (bio)sensor applications. The electrocatalytic reduction of oxygen on redox polymer modified working electrodes has been the object of active investigation in the last two decades. Many mediators such as VIII-B group metals, metal phthalocyanines, metal porphyrins, metal macrocyclic complexes, pyrimidine bases, naphthoquinone and anthraquinone derivatives were employed as electrocatalysts for the reduction of oxygen. Considering the growing importance of quinones as catalysts, many studies have been carried out using mediators with quinonic functions.

Synthetic dyestuffs are extensively used in many fields of industries of the man kind, e.g., textile, leather tanning, paint, paper production and food industries as well as agricultural research, photoelectrochemistry applications and hair colorings. The nomenclature of the dyes is based on the major functional group of the overall structure. The main classes are azo, anthraquinone, polymethine, phthalocyanine, sulphur, aminomethane, stilbene and coumarine dyes. Synthetic intermediates and degradation products of the dyes can be potential hazards because of their toxicity or carcinogenicity, therefore are of major environmental interest. The Oeko-Tex 100 standard is formed by The International Association for Research and Testing in the Field of Textile Ecology (Öko-Tex) in Zürich, Switzerland. This standard is applicable for textile and leather products and articles of all levels of production, including textile and non-textile accessories and deals with the listing and quantification of allergeneous and carcinogenic dyestuffs.

In this study, the glassy carbon electrode has been modified with polypyrrole and used for electrocatalytic reduction of oxygen in the presence of some anthraquinone type dyes. Commercially available disperse dyes, listed in the Oeko-Tex 100 standard, were obtained from Fluka. Their color index (CI) numbers are Disperse Blue 1, Disperse Blue 3, Disperse Red 11 and Disperse Orange 11, respectively (Figure 1). The catalytic effect of these dyes in dioxygen reduction at PPY/GCE was studied in various buffers between pH 1.0 and 13.0. Anthraquinones combined with polypyrrole exhibited potent electrocatalytic activities towards oxygen reduction. The adsorbed catalytic molecules reduced the oxygen at lower potential than the diffused molecules.

Figure 1. Chemical structure of Disperse Blue 1 (I), Disperse Blue 3 (II), Disperse Red 11 (III) and Disperse Orange 11 (IV).