EXCHANGED CATIONS AND WATER DURING DURING REACTIONS IN POLYPYRROLE MACROIONS FROM ARTIFICIAL MUSCLES

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Exchanged Cations and Water during Reactions in Polypyrrole Macroions from Artificial Muscles (pages 293–301)

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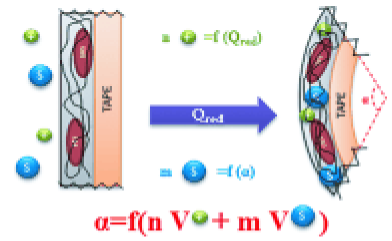

Putting some muscle into it: Bending bilayer (conducting polymer/tape) artificial muscles are used to quantify cations and solvent molecules exchanged by the dense conducting-polymer gel along the reactions driving muscle movement. The artificial muscles are faradaic polymeric motors, and both the rate of movement and the position have a linear relationship with the driving current and the consumed charge.

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Abstract

The movement of the bilayer (polypyrrole–dodecylbenzenesulfonate/tape) during artificial muscle bending under flow of current square waves was studied in aqueous solutions of chloride salts. During current flow, polypyrrole redox reactions result in variations in the volumes of the films and macroscopic bending: swelling by reduction with expulsion of cations and shrinking by oxidation with the insertion of cations. The described angles follow a linear function, different in each of the studied salts, of the consumed charge: they are faradaic polymeric muscles. The linearity indicates that cations are the only exchanged ions in the studied potential range. By flow of the same specific charge in every electrolyte, different angles were described by the muscle. The charge and the angle allow the number and volume of both the exchanged cations and the water molecules (related to a reference) between the film to be determined, in addition to the electrolyte per unit of charge during the driving reaction. The attained apparent solvation numbers for the exchanged cations were: 0.8, 0.7, 0.6, 0.5, 0.5, 0.4, 0.25, and 0.0 for Na^+, Mg^{2+}, La^{3+}, Li^+, Ca^{2+}, K^+, Rb^+, and Cs^+, respectively.