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Electrochemical strain under tensile stress in conducting polymers

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Conducting polymers can be electrochemically oxidized and reduced, resulting in deformation (electrochemical strain: EC strain) due to insertion and exclusion of ions, besides enormous change of the Electrical Conductivity. The phenomenon has been interested to utilize it for soft actuators. The maximum EC strain and stress in conducting polymer, polypyrrole were found to be 40%. These figures are superior to those of skeletal muscle of 25% and 0.5 MPa. Recently, we have shown that the size of ions doped in conducting polymer films could be estimated from the EC strain. The results were discussed with crystalline and hydrated ion radii. The EC stress (contraction force) is associated with the elasticity of polymers. In this talk, origins of EC stress in conducting polymers, polyaniline (PANi ES: emeraldine salt) and polypyrrole (PPy) are discussed taking the elasticity or Young's moduli (Y) of the films into account. The EC strains ($\Delta l/l_0$: $\Delta l=l-l_0$, where l and l_0 are the film length during EC cycle and the initial length, respectively), were measured as a function of tensile loads (f) in various electrolytes. Following figure depicts the typical tensile load dependence of EC stain, indicating that the EC strain decreases linearly against the tensile loads. From the gradient, electrochemical stress (E) is estimated, where $\Delta 5m/50$ is the maximum EC strain at the load free condition, and f_0 is blocking force. It was found that the EC stresses were 20Σ50 MPa in HCl, HBr, HBF₄, HClO₄ and H₂SO₄ doped PANi ES films and one order of magnitude smaller than Young's Moduli of 0.6Σ1 GPa. The detail origins of EC stress will be discussed.

Biography

Keiichi Kaneto has completed his PhD from Department of Electrical Engineering, Osaka University, Osaka, Japan. He is a Research Associate at the Faculty of Engineering, Osaka University, Osaka, Japan. He is the Professor of Computer Science and Systems Department, Kyushu Institute of Technology, Japan.

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