Conductance of Redox-active Single Molecule Junctions measured by Electrochemical Scanning Tunneling Microscopy

by

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ABSTRACT

Conductance of a single Fe (III) 5,15-di [4-(s-acetylthio) phenyl]10,20-diphenyl porphine (Fe porphyrin) molecule has been measured using a scanning tunneling microscope (STM) in air and in a potential controllable electrochemical system. A self-assembled monolayer (SAM) of Fe porphyrin is formed on Au (111) substrate. A metal-molecule-metal junction is formed by retracting the STM tip away from the Fe porphyrin SAM. The junction is repeatedly formed and numerous conductance vs. tip displacement (G-S) curves is recorded at fixed STM tip-substrate bias. Conductance histograms show two conductance states both at bias 0.5 V and 1.4 V in air. A conductance switching behavior is observed at both bias voltages. The molecule switches from a high conductance state (2.1×10^{-6} G_0) to a low conductance (1.5×10^{-6} G_0) state. The redox state of the Fe porphyrin molecule is found to be at -0.45 V (vs. silver wire) using cyclic voltammetry. Conductance measurements under potential control show a maximum value at the redox state. The causes of the different conductance states and the relationship between the conductance and the redox state are discussed.