271c Self-Assembly of Nanocomposite Molecular Films Containing Photosystem I

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Photosystem I (PSI) is a 5 nm x 6 nm protein complex that governs many of the primary events of photosynthesis, the key biological process that converts sunlight into chemical energy. Because of its nanoscale size and photovoltaic properties, PSI offers great potential for use in molecularly engineered energy conversion devices upon extraction from plants and assembly on surfaces. The research described in this paper focuses on the integration of spinach extracted PSI at model surfaces, formed by self-assembled monolayers (SAMs) on gold. Based on solution conditions, PSI adsorbs as either a densely packed (~6 nm) or loosely packed (~3 nm) monolayer atop a hydroxyl-terminated SAM. We have developed a unique method to stabilize the loosely packed monolayer of PSI by exposure to a solution of a long chain alkanethiol, which backfills around individual PSI complexes, mimicking the thylakoid membrane of green plants. This multicomponent monolayer greatly reduces interfacial capacitance and stabilizes PSI against photo-assisted degradation. The immobilized PSI complexes, either in the densely packed or stabilized states, are in direct electrical contact with the underlying gold surface and can be illuminated in the presence of a metal salt to grow metallic features at the reducing end. These nanoscale metallic pads will be used to integrate PSI with other conducting materials that serve as a sink for generated photocurrent. The ultimate goal of this research is to develop a photoelectrochemical device in which PSI converts solar energy into useful electrical energy.