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标题: The origin of an efficiency improving "light soaking" effect in SnO_2 based solid-state dye-sensitized solar cells

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摘要: We observe a strong "light-soaking" effect in SnO_2 based solid-state dye-sensitized solar cells (SDSCs). Both with and without the presence of UV light, the device's short-circuit photocurrent and efficiency increase significantly over 20-30 minutes, until steady-state is achieved. We demonstrate that this is not due to improved charge collection and investigate the charge generation dynamics employing optical-pump terahertz-probe spectroscopy. We observe a monotonic speeding-up of the generation of free-electrons in the SnO_2 conduction band as a function of the light-soaking time. This improved charge generation can be explained by a positive shift in the conduction band edge or, alternatively, an increase in the density of states (DoS) at the energy at which photoinduced electron transfer occurs. To verify this hypothesis, we perform capacitance and charge extraction measurements which indicate a shift in the surface potential of SnO_2 of up to 70 mV with light soaking. The increased availability of states into which electrons can be transferred justifies the increase in both the charge injection rate and ensuing photocurrent. The cause for the shift in surface potential is not clear, but we postulate that it is due to the photoinduced charging of the SnO_2 inducing a rearrangement of charged species or loss of surface oxygen at the dye-sensitized heterojunction. Understanding temporally evolving processes in DSCs is of critical importance for enabling this technology to operate optimally over a prolonged period of time. This work specifically highlights important changes that can occur at the dye-sensitized heterojunction, even without direct light absorption in the metal oxide.

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