Thick or Thin? Investigating How Electrolyte Viscosity Affects DSSC Efficiency and Stability

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About 730 million people globally lack access to electricity according to the International Energy Agency, emphasizing the need for low-cost, sustainable energy solutions. An alternative to the traditional silicon photovoltaics are dye-sensitized solar cells (DSSCs), which are simpler and cheaper. However, they fall behind in efficiency, long-term stability, and are reliant on volatile and toxic electrolytes or dyes. This study examined how electrolyte viscosity affects DSSC performance and stability over time. Cells were created using titanium oxide and organic blackberry dye as the photosensitizer with a graphite layer as a cathode. The electrolyte was mixed with vegetable glycerin, a biodegradable, low-toxicity compound, creating mixtures with concentrations of 0%, 25%, 50%, and 75%. Electrical performance was measured under consistent lamp illumination and long-term degradation was simulated through 1.5 weeks for each iteration under lamp illumination and sun exposure. Results revealed a direct relationship between viscosity and output. Peak performance was achieved at 50% glycerol (9.86 μW), higher than both the 0% control (2.11 μW) and 75% (0.054 μW), which had near-total efficiency loss. Higher viscosity also had greater stability: the 50% glycerol cells continued to produce significantly more power over time (52.3% decrease) compared to the control (83.0% decrease). These findings show that a moderate viscosity optimizes ion transport and reinforces electrolyte stability, whereas excessive viscosity impedes ionic diffusion and decreases performance. These findings establish electrolyte viscosity as a variable in DSSC design. Incorporating moderate amounts of glycerol as an additive can diminish the toxicity, increase stability, and enhance efficiency.

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