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Photoinduced Optical Transparency in Dye-Sensitized Solar Cells Containing Graphene Nanoribbons

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ABSTRACT: We describe the use of few-layer graphene nanoribbons, either attached to counter electrodes or dispersed into electrolyte, to induce optical transparency of an iodide/triiodide redox couple in a dye-sensitized solar cell (DSSC). We then evaluate the effect of reversible bleaching of the electrolyte on the DSSC performance. This bleaching effect is related to an energy transfer from photoexcited quantum-dot-like regions to the triiodide (I_3^-) radical ions in the electrolyte, saturating their absorption in the visible optical range. DSSC power conversion efficiency using few-layer graphene nanoribbons at the counter electrode (5.8%) did not deteriorate when the electrolyte became optically transparent. The increased transparency of the electrolyte resulted in a decreased photocurrent density (from 17.6 to 14.2 mA/cm^2), an unchanged open circuit voltage of 750 mV, and a slightly increased fill factor (from 0.45 to 0.55). When the few-layer graphene nanoribbons were introduced into the electrolyte directly by ultrasonication, a semitransparent DSSC was found to have increased its power conversion efficiency in an optically inverted setup from 5.75% to 7.01%, arising from an increase in photocurrent from 9.9 to 12.1 mA/cm^2. This significant photocurrent increase demonstrates that the effect of electrolyte bleaching can be used for further improving power conversion efficiency for inverted and tandem DSSCs, in which light has to pass through the electrolyte to generate photocurrent on one or more photocells.