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Star-shaped fluorene-BODIPY oligomers: Versatile donor-acceptor systems for luminescent solar concentrators

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Luminescent solar concentrators (LSCs) are waveguides doped with luminescent centers that can spectrally and spatially concentrate sunlight. They can reduce the cost of photovoltaic energy production and are attractive prospects for photobioreactors and building-integrated applications. Reabsorption, caused by non-zero overlap between the absorption and emission spectra of the light-emitting centers, often limits LSC efficiency. Donor–acceptor energy-transfer complexes are one method to mitigate reabsorption by shifting the emission away from the main absorption peak. Here we introduce versatile star-shaped donor–acceptor molecules based on a central BODIPY energy acceptor with oligofluorene donor side units. Varying the oligofluorene chain length alters the relative oscillator strengths of the donor and acceptor, changing the severity of reabsorption for a given donor density, but also changing the luminescence yield and emission spectrum. We performed comprehensive device measurements and Monte Carlo ray tracing simulations of LSCs containing three oligofluorene–BODIPY donor–acceptor systems with different oligofluorene chain lengths, and then extended the simulation to study hypothetical analogs with higher donor–acceptor ratios and different terminal acceptors. We found that the measured structures permit waveguide propagation lengths on a par with state-of-the-art nanocrystalline emitters, while the proposed structures are viable candidates for photobioreactor and energy production roles and should be synthesized.

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