Long-range energy transport in single supramolecular nanofibers at room temperature

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Efficient transport of excitation energy over long distances is a key process in light- harvesting systems as well as in molecular electronics [1]. However, in disordered organic materials the exciton diffusion length is typically in the order of ~ 10 nm largely determined by the probability laws of incoherent hopping [2]. Only for highly ordered organic systems has the transport of excitation energy over macroscopic distances been reported—for example, for triplet excitons in anthracene single crystals at room temperature [3], as well as for singlet excitons along single polydiacetylene chains embedded in their monomer crystalline matrix at a temperature of 10 K [4]. In contrast, at room temperature uniaxial, μm-long transport along self-assembled organic nanostructures has not been demonstrated.

Here we demonstrate that tailored supramolecular building blocks based on carbonyl-bridged triarylamines as π-conjugated core allows for the preparation of individual supramolecular nanofibers with molecular diameter. These nanofibers efficiently transport singlet excitons at ambient conditions over distances of more than 4 μm, which is only limited by the fiber length. Our data suggest that this remarkable long-range transport is predominantly coherent, which is achieved by the one-dimensional self-assembly of the building blocks [5] to well-defined H-aggregates with substantial electronic interactions [6]. These findings may pave the way for the development of novel organic nanophotonic devices as well as quantum information technology.

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