Effects of conjugation length on crystalline perfectness and charge transport in diketopyrrolopyrrole-based polymer semiconductors

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In order to improve the charge carrier mobility of the diketopyrrolopyrrole donor-acceptor copolymer semiconductors, the length of the donor building block is controlled using vinylene moieties and its effect on crystal structure and charge transport is systematically studied. We synthesize P29-DPP-TBT with two vinylene linkages between thiophene units and compare it with P29-DPP-TVT with single vinylene linkage. In a two-dimensional grazing incidence X-ray diffraction study, it was found that paracrystalline disorder was lower in P29-DPP-TBT than in P29-DPP-TBT. By measuring the temperature dependence of charge carrier mobility, it has been found that the activation energy for charge transfer hopping to P29-DPP-TBT is lower than that of P29-DPP-TBT. Taken together, these results imply that the substitution of extended π-conjugated donor moiety of polymeric semiconductors can yield a more planar backbone structure and thus enhanced intermolecular interaction which enables more perfect crystalline structure as well as enhanced charge transport behavior.