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Parity violation in supramolecular aggregation: Insights from optoelectronic properties

The Maxwell electromagnetic equations obey parity (P), however, Wu et al, first proved a clear violation of parity conservation in the beta decay of cobalt-60. [1] It is now widely believed that in physical systems having weak interactions parity violation is possible. Now the question is if it is true in physical systems why not in chemical systems, particularly where there is self-aggregation via weak physical interactions. In the contemporary science, it is believed that supramolecular chiral structures (left- or right-handed and P- or M-helices) emanating from enantiomeric (L- or D-enantiomers) chiral building blocks would have identical physical and chemical properties. [2] Here we show that the chiral perylenebisimide (PBI) derivatives containing enantiomeric L- or D- phenylalanine self-assemble to mirror image helical supramolecular structures with dissymmetric energy states. We have synthesized PBI derivatives with chiral L- and D- phenylalanine at the imide positions and designated as PPAL and PPAD. Surprisingly, they exhibit different optoelectronic characteristics in the supramolecular aggregated state in chlorinated solvents. A detailed analysis of these systems by microscopy, X-ray scattering and spectroscopy in different and mixed solvents reveal that PPAL affords compact self-assembled structure with long-range order than PPAD. Thus, with increase of concentration the aggregated molecules gives smaller scope to interact with the added molecule due to rotational restriction etc, thus with increasing concentration the weak interaction becomes weaker yielding different optoelectronic properties between D and L-isomers in the self-assembly, causing parity violation. These studies may provide a great impetus in understanding the origin of the evolutionary conserved L-amino acids in nature and will have important impact towards designing efficient optoelectronic devices with chiral organic supramolecular materials.

1. C.S. Wu et al., *Phys. Rev.* 105 (1957), 1413.
2. M.B. Avinash, T. Govindaraju, *Adv. Funct. Mater.* 21 (2011), 3875–3882.

Preferred topic

Conformation of polymers in solvents

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