Department of Physics
Condensed Matter Physics
Clarendon Laboratory, Parks Road, Oxford OX1 3PU

UNIVERSITY OF OXFORD

CONDENSED MATTER SEMINAR

Thursday 4 May at 14:30
Simpkins Lee room

*"***Chiral functional materials as a platform for emerging electronics***"*

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The use of organic semiconductors as low-cost, lightweight, easy-to-process active layers in optoelectronic devices has attracted considerable research and technological interest for over thirty years. Chiral organic semiconductors (i.e. organic semiconductors that exist as left- and right-handed non superimposable mirror image pairs) offer unparalleled opportunity to control electron and photon spin, due to a combination of their unique optical, electrical and magnetic properties. In organic light emitting diode (OLED) displays, circularly polarised luminescence (CPL) can greatly enhance the efficiencies and operational lifetimes by circumventing optical losses to the anti-glare filter. Photodetectors that are sensitive to CP light could be used in the enantioselective detection of biomolecules, which would improve the sensitivity of biosensors. As single-handed chiral molecular systems can filter electron spins at room temperature, chiral materials have the potential for a paradigm shift in the use of organic semiconductors in next-generation quantum technologies.

In recent years we have made considerable progress in the realisation of high performance of CP OLEDs and CP OPDs, and uncovered several fascinating chiral optical phenomena. We have established that the combination of conjugated polymers with small molecule chiral additives can generate very large dissymmetry factors (or g-factors; a measure of how strongly light is circularly polarised) owing to enhanced magneto-electric dipole coupling between adjacent chromophores. When a π-extended superhelicene is embedded within this polymer matrix we observed an almost 103-fold chiroptical amplification of the superhelicene luminescence signal, |gPL| (3×10−4 in solution to 0.15 in the blend). We propose that this remarkable amplification arises due to electrodynamic coupling between the electric and magnetic transition dipoles of the polymer donor and superhelicene acceptor, and subsequent CP Fluorescence Resonance Energy Transfer. Finally, we have recently demonstrated that organic and inorganic templating layers can be used to control the assembly of chiral small molecules, a highly important observation that offers hope for spin-filtering charge injection layers in spintronic devices.

We believe that the consideration of molecular chirality represents a simple and versatile approach to enhancing the performance of existing organic electronic devices, and presents an exciting pathway to the realisation of next-generation technologies and novel applications.

Host: Moritz Riede