Anisotropic magnetic-field effects in OLEDs at geomagnetic field strengths – a model for avian magnetoreception?

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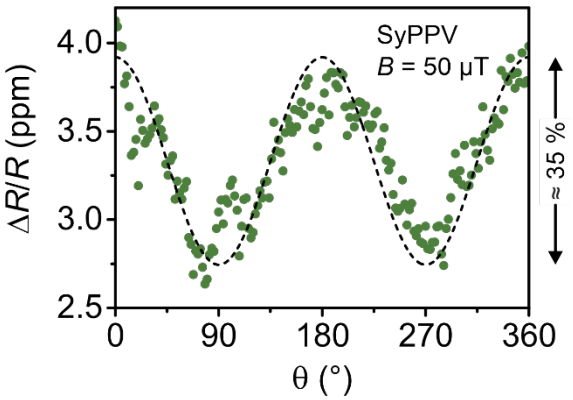
Although the effect of magnetic fields on the resistance and electroluminescence of organic light-emitting diodes (OLEDs) has been extensively studied, only little attention has been paid to the orientational dependence of these effects [1]. This aspect becomes of particular relevance when considering that the radical-pair mechanism, responsible for some of the magnetic-field effects in OLEDs, is currently the most promising candidate for the explanation of natural magnetoreception [2, 3].

We investigated magnetic-field effects in OLEDs in the regime of ultrasmall fields (< 2 mT). For both device resistance and electroluminescence, an anisotropy is observed, with magnitude and symmetry depending on the magnetic-field strength. Our results show that OLEDs can act as a compass sensor at fields as weak as Earth's magnetic field. In order to gain a better understanding of the underlying mechanisms, we compare our experimental results to simulations based on the density-matrix formalism [4]. We identify microscopically anisotropic distributions of hyperfine fields in combination with finite macroscopic molecular order as the primary cause for the observed angle-dependent magnetic-field effects.



Anisotropic relative magnetoresistance $\Delta R/R$ of an OLED showing compass behavior at B = 50 µT.

To disentangle the different sources of anisotropy in polymer OLEDs, electrically detected magnetic resonance (EDMR) can act as a useful tool since it reveals the hyperfine-field distributions experienced by charge-carrier spins. Angle-dependent EDMR measurements are considered, which enable constraints on the balance between microscopic and macroscopic sources of anisotropy to be formulated. Furthermore, our results indicate that the anisotropy in OLED magnetic-field effects decreases under resonant RF radiation, in analogy to the disorientation of birds exposed to RF magnetic fields [2].

References

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[3] J. Xu *et al.*, *Nature* **594**, 535 (2021)
[4] S. Jamali *et al.*, *Nat. Commun.* **12**, 465 (2021)