MAR07-2006-004317

Abstract for an Invited Paper
for the MAR07 Meeting of
the American Physical Society

Characterization and Application of Large Magnetoresistance in Organic Semiconductors[1]

MARKUS WOHLGENANNT, University of Iowa

Recent years have seen a surge in interest in magnetoresistive and spintronic properties of organic semiconductors, whereas this field was previously almost exclusively concerned with their electrooptical properties. We report on the extensive experimental characterization of a recently discovered large and intriguing magnetoresistive effect in organic light- emitting diodes that reaches up to 10% at room temperature for magnetic fields, B = 10mT. This magnetoresistive effect is therefore amongst the largest of any bulk material. The study includes a range of materials that show greatly different chemical structure, mobility, hyperfine and spin-orbit coupling strength. We show that the applied magnetic field affects the carrier transport inside the bulk semiconductor. By demonstrating that the effect is critically altered by the presence of strong spin-orbit coupling and that it does not occur in fullerene devices, we prove that the transport in organics sensitively depends on spin-dynamics induced by hyperfine interaction with the hydrogen protons. We discuss a possible relation between organic magnetoresistance and other magnetic field effects in organics that were known long before its discovery. As a possible mechanism we describe how Pauli's principle restricts carrier hopping between singly occupied sites near the Fermi level. However, spin-mixing by the hyperfine interaction may partially lift this restriction. Since the devices we describe can be manufactured cheaply they hold promise for applications where large numbers of magnetoresistive devices are needed, such as magnetic random- access-memory (MRAM); and applications related to organic light- emitting diode displays such as touch screens where the position of a magnetic stylus is detected (patent pending). We will show a video of a simple demonstrator device.

[1]This work was supported by NSF Grant No. ECS 04-23911.