IX-B Development of Organic Semiconductors for Molecular Thin-Film Devices

Organic light-emitting diodes (OLEDs) and organic field-effect transistors (OFETs) based on π-conjugated oligomers have been extensively studied as molecular thin-film devices. Organic semiconductors with low injection barriers and high mobilities are required for highly efficient OLEDs and OFETs. Radical cations or anions of an organic semiconductor have to be generated easily at the interface with an electrode (or a dielectric), and holes or electrons must move fast in the semiconducting layer. Compared with organic p-type semiconductors, organic n-type semiconductors for practical use are few and rather difficult to develop. Recently, we found that perfluorinated aromatic compounds are efficient n-type semiconductors for OLEDs and OFETs.

IX-B-1 Organic Thin-Film Transistors with High Electron Mobility Based on Perfluoropentacene

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We report on n-channel organic thin-film transistors (OTFTs) based on the novel n-type organic semiconductor, perfluoropentacene. The transistor exhibits excellent electrical characteristics, with a high electron mobility of 0.22 $cm^2/(V\ s)$ and a good current on/off ratio of 10^5. The electron mobility is comparable to the hole mobility of a pentacene OTFT. By combining the n-type perfluoropentacene and the p-type pentacene, we have fabricated ambipolar OTFTs and complementary inverter circuits. The OTFTs with heterostructures of the p- and n-type organic semiconductors can operate as an ambipolar device with high electron and hole mobilities of 0.042 and 0.041 $cm^2/(V\ s)$. The complementary inverter using an n-channel perfluoropentacene OTFT and a p-channel pentacene OTFT exhibits excellent transfer characteristics with a voltage gain of 45. A complementary inverter using the ambipolar OTFTs is also demonstrated.

IX-B-2 Organic Light-Emitting Diodes Using Multifunctional Phosphorescent with Iridium-Complex Core and Charge-Transporting Dendrons

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We report a novel class of light-emitting materials for use in organic light-emitting diodes (OLEDs): multifunctional phosphorescent dendrimers that have a phosphorescent core and dendrons based on charge-transporting building blocks. We synthesized first-generation and second-generation dendrimers consisting of a *fac*-tris(2-phenylpyridine)iridium [$Ir(ppy)_3$] core and hole-transporting phenylcarbazole-based dendrons. Smooth amorphous films of these dendrimers were formed by spin-coating them from solutions. The OLEDs using the dendrimer exhibited bright green or yellowish-green emission from the $Ir(ppy)_3$ core. The OLEDs using the film containing a mixture of the dendrimer and an electron-transporting material exhibited higher efficiency than those using the neat dendrimer film. The external quantum efficiency of OLEDs using the film containing a mixture of the first-generation dendrimer and an electron-transporting material was as high as 7.6%.

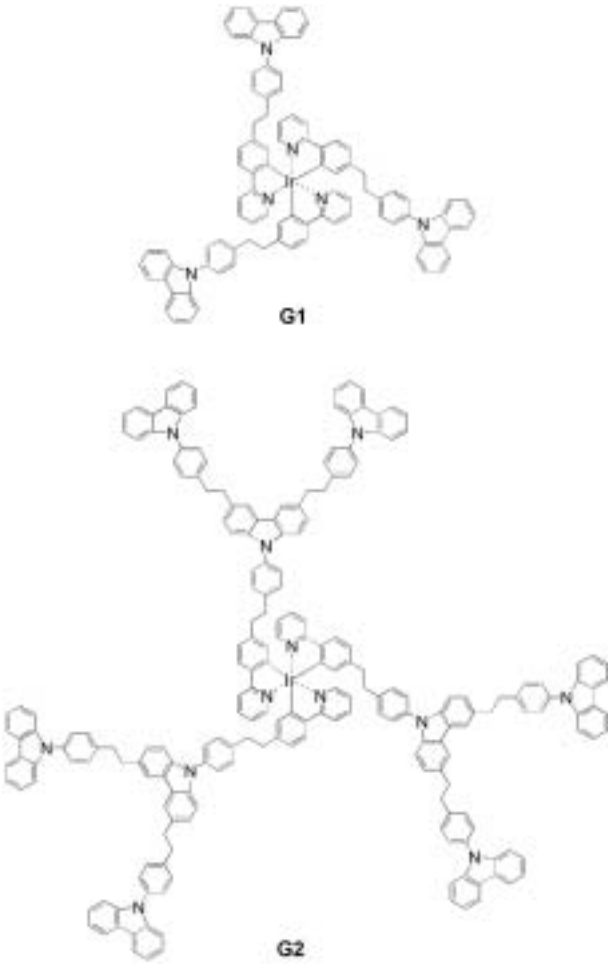

Figure 1. Structures of iridium complexes.