N-Type Organic Semiconductor Formulations, Devices

Background
Organic electronics can be manufactured at lower cost compared to conventional silicon-based electronics and are suitable for widespread applications including, but not limited to, displays, radio-frequency identification (RFID) tags, chemo/biosensors, memory devices, solar cells, photodiodes, thermoelectric devices, and batteries. In addition, organic semiconductors can be processed at low temperatures and deposited on plastic substrates to enable lightweight, flexible, and ultra-thin electronic devices. In order to build organic electronics, such a organic thin film transistors (OTFTs) and organic photovoltaics, both p-type and n-type semiconductors are required. Although there are several high performance p-type organic semiconductors, to date the only viable n-type organic semiconductors transport both electrons and holes (ambipolar) which consume more power when utilized in organic electronic devices. Thus there is a need to develop a high performance "true" n-type organic semiconductors to match their peer p-type organic semiconductors (i.e electron mobility greater than 0.5 cm$^2$V$^{-1}$S$^{-1}$)

Description of the invention
Waterloo researchers have developed novel n-type organic semiconductor formulations and devices comprising an organic semiconductor (OSC) and an organic phosphorous-containing functional additive (OPA) capable of enhancing the n-type performance of the OSC. These novel formulations are solution processable, result in air-stable n-type polymer semiconductors, and provide electron mobility greater than 0.5 cm$^2$V$^{-1}$S$^{-1}$.

Advantages
These n-type organic semiconductors formulations and devices show mobility of greater than 0.5 cm$^2$V$^{-1}$S$^{-1}$, without the drawback of the higher power requirements associated with existing ambipolar n-type semiconductors. This organic semiconducting material utilizes cheap existing materials and can be processed in solution at low temperatures and thus easily deposited on plastic substrates to enable lightweight, flexible, and ultra-thin electronic devices.

Potential applications
These n-type organic semiconductor materials could be used in: organic field effect transistors (OFET), thin film transistors (TFT), integrated circuits (IC), logic circuits, capacitors, radio frequency identification (RFID) tags, devices or components, organic light emitting diodes (OLED), organic light emitting transistors (OLET), flat panel displays, backlights of displays, organic photovoltaic devices (OPV), organic solar cells (OSC), photodiodes, laser diodes, photoconductors, organic photodetectors (OPD), electrophotographic devices, organic memory devices, sensor, charge injection layers, charge transport layers, polymer light emitting diodes (PLEDs), Schottky diodes, antistatic films, polymer electrolyte membranes.