From Polymers to Carbon Nanotubes: Semiconductors for New Optoelectronic Devices

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In recent years a wide range of novel and unusual semiconductors have been investigated as materials for optoelectronic devices. These include conjugated polymers, single-walled carbon nanotubes and quantum dots. Apart from their interesting electronic and optical properties they also enable new types of devices. One of them is the light-emitting field-effect transistor (LEFET) that combines the high charge carrier densities and switching capabilities of field-effect transistors with the light-emitting properties of these semiconductors. Holes and electrons are injected from the source and drain electrodes and recombine in a narrow emission zone within the channel. One of its most interesting features is the ability to position this emission zone arbitrarily along the channel by changing the applied voltages. Here, I will demonstrate a few examples of LEFETs based on various semiconducting materials and discuss their applications, for example, the integration of plasmonic nanoantennas in near-infrared emitting LEFETs and thus voltage-tunable coupling of excitons to surface-plasmon polaritons, the direct investigation charge transport within networks of semiconducting single-walled carbon nanotubes (SWNTs) with different bandgaps and the observation of trion (charged exciton) emission at high carrier densities.