Biodegradable Light-Emitting Diodes (LED's) for biophotonic applications

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Abstract

Transient electronic devices, such as light-emitting diodes (LEDs), have garnered significant attention for optical-based biosensing, photodynamic therapy and optogenetics.[1-4] This technology focuses on using biocompatible and biodegradable materials that gradually degrade inside the human body without triggering a major inflammatory response, thereby avoiding potential harm to the patient.[5-6] Currently, the major challenge in designing a fully biodegradable LED for the biomedical industry is identifying the right combination of materials that have the proper electrical, optical, mechanical and biocompatible qualities, as well as, thermal stability and compatibility with the required fabrication processes.[7-9] In this work, we report a transparent and flexible LED device where all the components, including substrate, active layer and electrodes, are completely biocompatible and biodegradable. The substrate was made of chitosan, a polysaccharide present in the exoskeletons of insects and crustaceans widely used in drug delivery nanocarriers but poorly explored for developing transient electronic devices. The biodegradable electrodes were made of magnesium, a metal that easily dissolves in water and human body fluids. The bis[4-(9,9-dimethyl-9,10-dihydroacridine)phenyl]methanone (DMAC-BP), a biocompatible and hydrolysable thermally activated delayed fluorescence material, served as active layer of the device. The results showed that the LED device is biocompatible, biodegradable, flexible, operates at voltage (4-5V) and current values that are safe for the human body and exhibited a stable green emission at 510 nm, which can be used for activating photosensitizers (like doxorubicin) in cancer therapy.

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