PLASMONIC-ENHANCED FLUORESCENT CONJUGATED POLYMER CHEMOSENSOR FOR ULTRA-SENSITIVE DETECTION OF NITROAROMATIC VAPORS

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ABSTRACT

Rapid degradation of fluorescent conjugated polymers in ambient conditions imposes severe restrictions on their utility for long-term, portable sensing applications. This dissertation discusses the combined use of low-density, ultra-thin oxide capping layers and plasmonic silver gratings as a means of improving fluorescent conjugated polymer ultra-thin films (<50 nm) for long-term, portable chem/bio sensing applications. Silver gratings produced by low-cost micro-contact printing method enhanced poly-[2-methoxy-5-(2-ethylhexyloxy)-p-phenylenevinylene] (MEH-PPV) emission by 12-fold with respect to films on flat silver by surface plasmon-coupled emission, which directs specific emitted wavelengths toward the microscope detection window. Addition of a low-density, ultra-thin silica capping layer improved MEH-PPV photostability significantly with respect to uncapped films under both short-term continuous illumination as well as long-term storage in dark, ambient air, while retaining a rapid quenching response to nitroaromatic vapors. Capped, plasmonic-enhanced MEH-PPV film showed a response to 2,4-dinitrotoluene vapor at a rate more than 7-fold faster than capped films on SiO_2-coated silicon, attributed to a combination of sensitization effects of the silver on the conjugated polymer molecules in close proximity to the metal. Lateral diffusion of nitroaromatic vapor into the film is visualized through ‘growth’ of quenched regions in fluorescence images. Most importantly, the devices recover fluorescence spontaneously on removal from the nitroaromatic vapor source, suggesting they could be used for long-term, real-time measurements of nitroaromatic vapors.