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Nanoparticles of Semiconducting Polymer with Multimodal Biophotonics

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Abstract

Modern biomedical science is increasingly reliant on the interdisciplinary frontier of biophotonics. In biophotonics, optical agents typically play a role in converting photons into other forms of energy (like heat, mechanical force, or chemical radicals) for therapeutic intervention or biological stimulation, or in interpreting biomolecular events into readable optical signals for imaging and diagnosis. This field has advanced thanks to the creation of new optical agents such metallic nanoparticles, quantum dots, up-conversion nanoparticles, carbon dots, and silica nanoparticles. But the majority of these agents have their own advantages and disadvantages, which reduces their usefulness as multimodal biophotonic platforms. The cladding material can be perfectly index-matched to an optically probed sample solution because to the special refractive index of CYTOP (n=1.34). Additionally, it is possible to create ultra-high index contrast waveguides utilising common optical polymers as the waveguide core materials, opening the door to the comprehensive integration of optical functions on a single chip. We address how this platform can be used for evanescent-wave excitation fluorescence microscopy, on-chip light generation, passive and/or thermoelectrically controlled on-chip light manipulation, and direct integration with microfluidic circuits through low temperature bonding.

Keywords: ***Fluorescence microscopy; Integrated biophotonics; Fluoropolymers; Biosensors; Core materials***

Introduction

Over the past three decades, biophotonics, the study at the intersection of light and biological matter, has advanced significantly. Light based technology advancements have produced ground breaking and revolutionary instruments for the analysis and control of biological systems at the subcellular, cellular, tissue, and organ levels. Therefore, it is anticipated that bio photonics will be essential to the development of the 21st century's diagnostic, analytical, and therapeutic modalities. This is amply evidenced by a number of recent global projects that integrate biophotonics as a key tenet, as well as by the field's fast growing body of scholarly literature and industrial development. Examples include "towards 2020 photonics supporting economic growth in Europe, multiannual strategic roadmap 2014 to 2020"3 in Europe, "PhotonicsSA Roadmap"4 in Australia, and the "National Photonics Initiative (NPI)" and the NPI's "cancer moonshot task force" located in the United States. Through these initiatives, the potential for biophotonics to address significant societal issues has been identified.

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Description

Examples include the development of medical devices for the management of human diseases, the advancement of highly sensitive devices for advanced pollution detection, and the provision of tools for evaluating quality control and safety in food and agriculture, as well as the improvement of environmental health. The international year of light is a global initiative to increase awareness of how light based science and technologies promote sustainable development and offer solutions to global challenges in energy, education, agriculture, and health. The United Nations general assembly recognized the significance of light and optical technologies by naming 2015 the international year of light.

Conclusion

We have shown that a number of integrated biophotonic devices can utilise the amorphous fluoropolymer CYTOP. The refractive index of CYTOP and its compatibility with other polymers and biological samples provide up a wide range of intriguing opportunities for the construction of small-scale bio photonic circuits. We described how to make electrically controlled modulators, switches, and optically pumped on-chip light sources, which are all suited for large scale integration of optical functionalities. A successful demonstration of direct integration with PMDS microfluidic circuits was also made. In comparison to traditional waveguide designs using glass substrates, the symmetric cladding environment for aqueous samples offers increased refractive index sensitivity and greater control over the penetration of the evanescent field into the sample solution.