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Flexible and Color Tunable Inorganic Light Emitting Diode Array for High Resolution Optogenetic Devices

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Abstract : Light emitting diode (LED) array is an ideal optical stimulation tool for optogenetics, which controls inhibition and excitation of specific neurons with light-sensitive ion channels or pumps. Although a fiber-optic cable with an external light source, either a laser or LED mechanically connected to the end of the fiber-optic cable has widely been used for illumination on neural tissue, a new approach to use micro LEDs (μLEDs) has recently been demonstrated. The LEDs can be placed directly either on the cortical surface or within the deep brain using a penetrating depth probe. Accordingly, this method would not need a permanent opening in the skull if the LEDs are integrated with miniature electrical power source and wireless communication. In addition, multiple color generation from single μLED cell would enable to excite and/or inhibit neurons in localized regions. Here, we demonstrate flexible and color tunable μLEDs for the optogenetic device applications. The flexible and color tunable LEDs was fabricated using multifaceted gallium nitride (GaN) nanorod arrays with GaN nanorods grown on InxGa1−xN/GaN single quantum well structures (SQW) anisotropically formed on the nanorod tips and sidewalls. For various electroluminescence (EL) colors, current injection paths were controlled through a continuous p-GaN layer depending on the applied bias voltage. The electric current was injected through different thickness and composition, thus changing the color of light from red to blue that the LED emits. We believe that the flexible and color tunable μLEDs enable us to control activities of the neuron by emitting various colors from the single μLED cell.

Keywords : light emitting diode, optogenetics, graphene, flexible optoelectronics
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