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Particle and Molecule Electronics using Micro-optical Circuits: The Future Challenges

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Editorial

Optical microring resonator has been the promising device in nano-communication for a high-speed, large-scale platform. A microring add-drop filter consists of one input port, one microring resonator, and two out ports. The microring resonator serves as a selector for optical carriers and wavelengths. The selected optical wavelength can be routed to one output port and the rest of the wavelengths are transmitted to the other output port. These three-port devices function as switches to route optical signals to different output ports, allowing further integration of various devices on the same platform. Therefore, microring add-drop filters are the crucial basic building block of large-scale, multi-stage silicon photonic systems.

An optical add-drop filter device is the other form of miscroring resonator usage, which is an essential component in silicon photonics. It has shown the convincing challenges for particle or molecule electronics, especially, after the practical trapping particle work has been strongly confirmed by Cai and Poon [1-4], where particle or molecule could be transported within the add-drop optical filter. The concrete concept of theoretical manipulation of ring resonator has also been confirmed by Yupapin team [5,6], from which many applications have been investigated [7-10]. Moreover, Yupapin research team has shown that the modified add-drop optical filter called a Panda ring resonator has shown more benefits than the ordinary add-drop filter [11-17], from which the two nonlinear side rings are made from the nonlinear material types that can produce may aspects of applications, for instance, high channel capacity, fast switching time and wide sensing range of application etc. The used nonlinear materials can be the grapheme material, AlGaAs/InP and others. Figure 1 shows the structure of a Panda ring resonator that can be fabricated and tested.

Figure 2 shows the leaky modes and whispering gallery mode of light within the Panda ring resonator, which can be configured to be surface plasmon pulse, potential wells, tweezers, dynamic quantum dot and whispering gallery modes [18-21], which can be involved and used for many applications, especially, for optical trapping probe. Optical trapping is a field of nano-technology that focuses on precise control of single particles, such as viruses, blood cells, or drugs. Optical trapping experiments in laboratories have dramatically increased our understanding of biological processes [1-4].

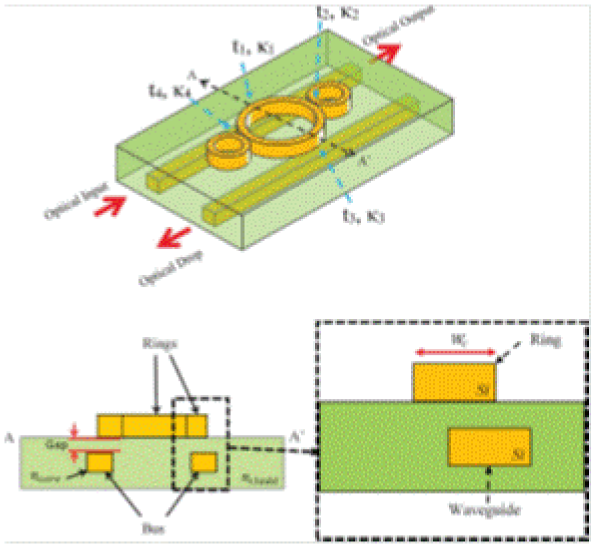

Figure 1: A schematic of Panda ring resonator [8]

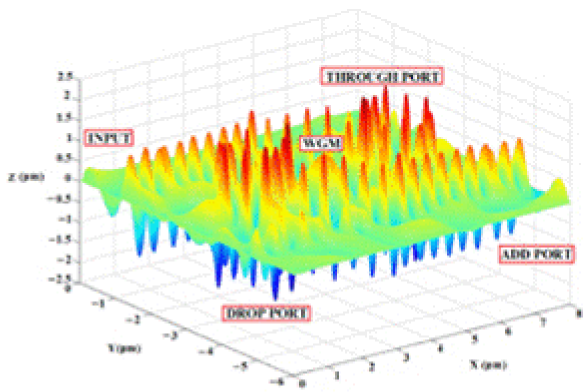

Figure 2: Potential wells and tweezers [21]

Apparently, all forms of light travelling within a Panda ring resonator can be described for instance (i) wave propagation by ray tracing, (ii) particle aspect by Schrodinger equation and (iii) the leaky modes and whispering gallery modes (WGMs) [20,21]. In this short article, the future challenging works such as dynamic quantum dot, potential well and tweezers, particle and molecule electronics can be investigated in both theoretical and experimental works. One of the challenged devices is the quantum dot based on photonic device, where in this aspect the dot can be in the forms of potential wells, which can be constructed by the leaky modes or WGMs, from which the transparent and tunable quantum dot can be constructed by the external control environments, which is shown in Figure 2. The coupling between the potential wells within the device (Panda ring) can affect to the device outputs, which will be the desired quantum dot output. Such a device has the advantage is that it can be functioned to be (i) transparent and tunable quantum dot, (ii) easy to fabricate, (iii) suitable for many applications. Moreover, the use of such a device for particle and molecule electronics is also the interesting aspects, especially, when the trapped particles of molecules are involved, where the other forms of devices(electronics device) can be used and realized.

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