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## Improvement of Upconversion Process using Metamaterial Mirror

Young Jin Lee <sup>1</sup>, Kihwan Moon <sup>1</sup>, and Soon-Hong Kwon <sup>1</sup>

<sup>1</sup>*Chung-Ang Univ., Korea, Republic of*

In general, semiconductor optical devices can be operated only at specific target wavelength range due to finite band gap of its composed materials. Upconversion (UC) process is one of alternative way to use the wasted photons by converting near-infrared (NIR) to visible. Consequently, UC process extends spectral operation range of device. The NaYF<sub>4</sub> codoped Yb<sup>3+</sup> and Er<sup>3+</sup>, known as one of best UC materials, absorbs photons around 970 nm and emits lights with 660 nm. However, the efficiency of UC process, the NIR absorption and visible emission efficiency, is still low not enough to apply practical devices. In this research, we suggest a nanostructure, called by metamaterial mirror, for improving the efficiency of the UC process in a layer with a thickness of 100 nm. The concentrated electric fields in thin UC layer by the metamaterial mirror increase the light-matter interactions and eventually improve the absorption of NIR (970 nm) light 5.26 times. In addition, surface plasmon polariton (SPP) modes induced at wall of the grooves enhance the SE rate 106 times by Purcell enhancement, showing the enhanced emission of visible light. Finally, a metamaterial mirror that improves UC process efficiency by 558 times can be applied to optical devices using visible light such as solar cells.