Super Resonance from Gain-Assisted Silicon Nanowires

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Active coated nanoparticles can provide large coefficients to compensate the loss of surface plasma. In 2009, Noginov et al. demonstrated a spaser nanostructure composed of a gold core and a silica shell containing gain material. But nanostructures consisted of semiconductor nanoparticles coated with gain material doped shells have drawn great attention of many researchers for overcoming inherent defects in metals. Furthermore, such nanostructures can exhibit magnetic effects without complex designs.[1,2,3,4]

Here, we report super resonance from gain-assisted silicon nanowires, where one-dimensional periodic silicon lines are placed on top of a silica layer. The super resonance at 529 nm is confirmed from the emission spectrum governed by the width of the silicon lines and the thickness of the doped silica shells with the finite-difference time-domain (FDTD) method. The excellent performance of super resonance based on high-order magnetic resonance is demonstrated, for the first time to the best of our knowledge, by use of semiconductor nanostructures with dye doped silica shells. We show that the stimulated emission enhanced by coupling between Si nanowires and the dye molecules embedded in shells at appropriate dimensions. The enhanced near-field of active nanostructures, compared to passive nanostructures, is also been found.

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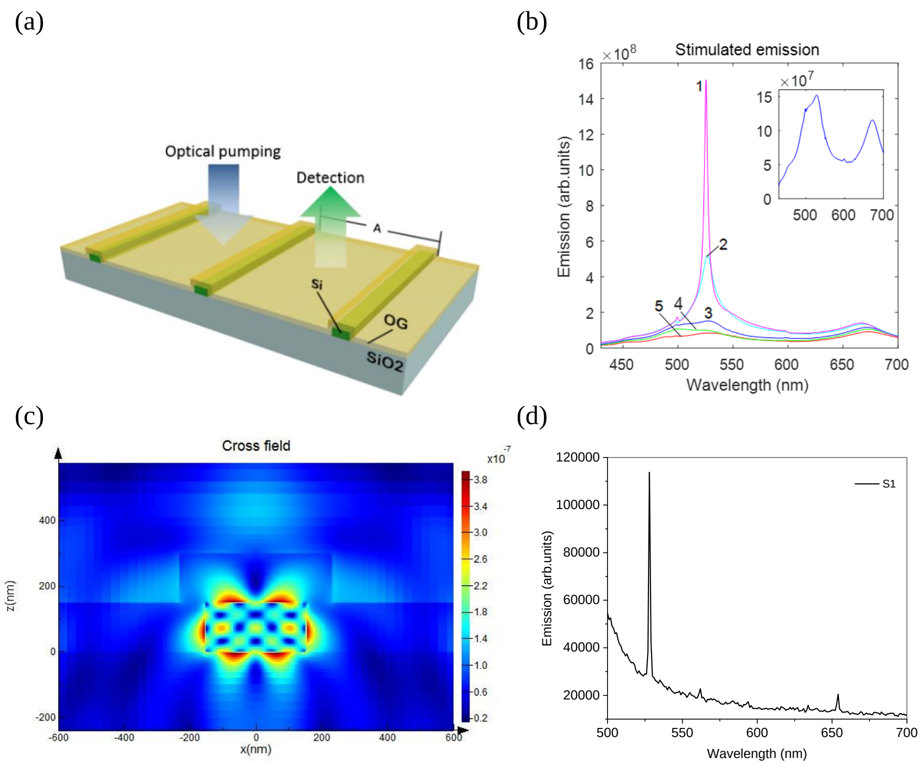

Figure 1: (a) Schematic of single Si line and experimental configuration. (b) Calculated stimulated emission spectra of single Si/silica/dye nanostructures (304nm wide Si line and 80nm thick doped silica shell on the side and 150nm on the top of Si lines) pumped with 398.2mW (1), 75.7mW (2), 39.8mW (3), 31.9mW (4) and 19.9mW (5). (c) Cross section view of field of active single Si line system with $\lambda = 528.544$ nm. (d) Stimulated emission spectrum of the nanostructure sample.