Enhanced Photoluminescence of MoS_2 by Gold Plasmon

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Introduction

Research on plasmonics in hybrid structures of graphene and metal nanostructures has led to a surge of interest in other atomically thin two dimensional (2D) materials, especially MoS_2. It has been reported that with the decoration of gold nanoparticles, 2D MoS_2 field effect transistor displays an enhanced photocurrent. However, there have been no in-depth reports yet on the plasmonic interaction mechanism between metallic nanostructures (MN) and 2D MoS_2. Moreover, current published work addresses only devices with gold nanoparticles randomly distributed on MoS_2. In our work, we demonstrate the precise patterning of MN on 2D MoS_2 and investigate the effect of metal patterns on the optical response of MoS_2.

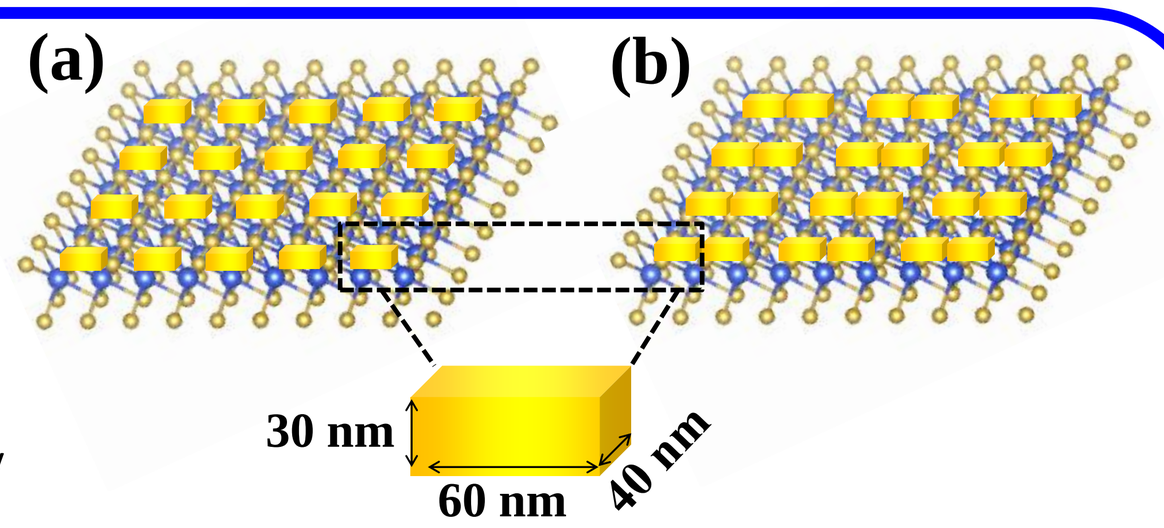

Figure 1. Schematic of (a) gold single antenna and (b) gold dimer antenna on MoS_2 grown by chemical vapor deposition. Gold rod has length 60 nm, width 40 nm, height 30 nm, and pitch size 500 nm; the gap between dimer rods is 20 nm.

Results and Discussion A:

Photoluminescence (PL) of MoS_2 with and without antenna

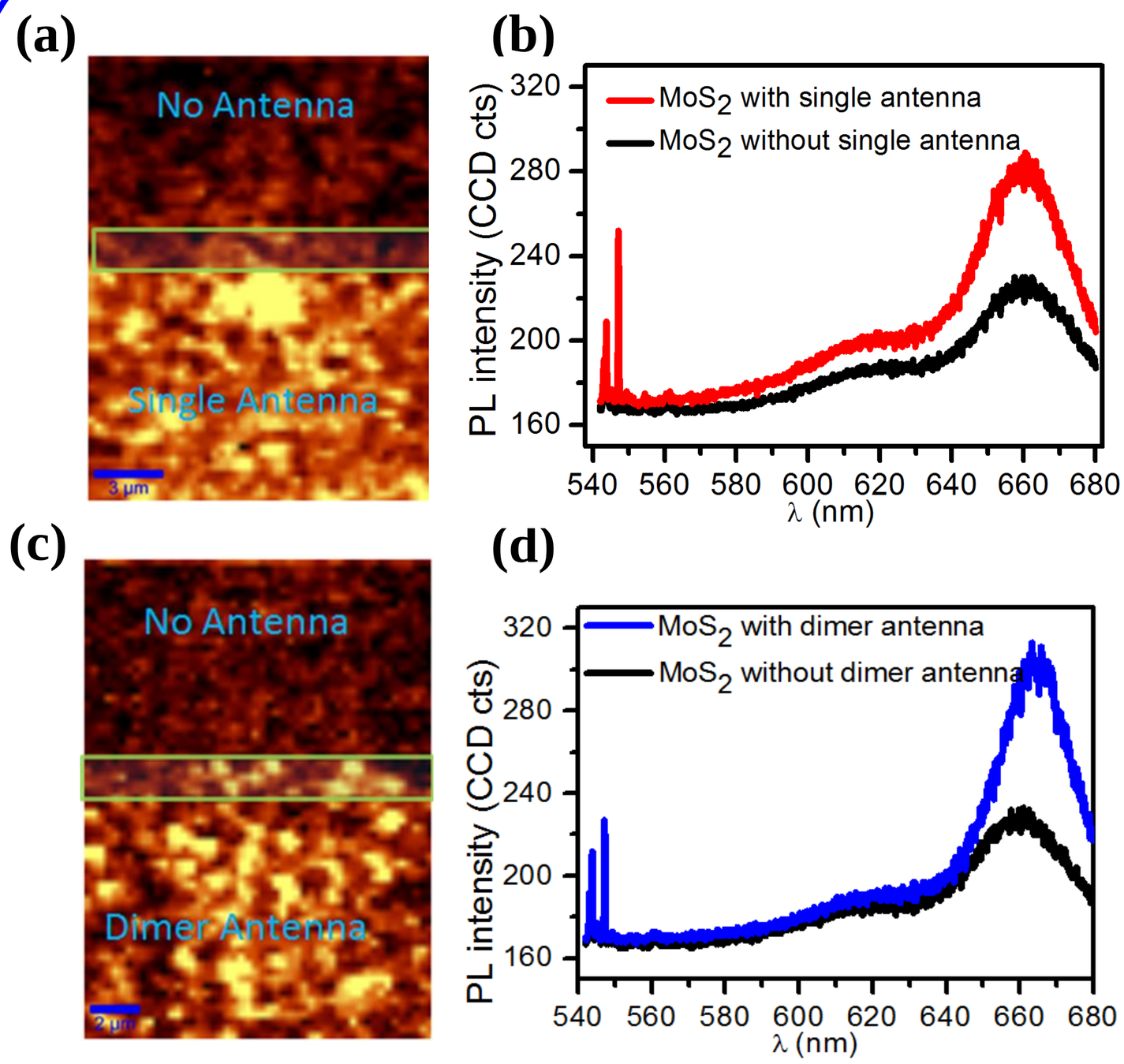

Figure 2 (a) PL mapping and (b) PL intensity of MoS_2 with and without gold single antenna ; (c) PL mapping and (d) PL intensity of MoS_2 with and without gold dimer antenna.

Results and Discussion B

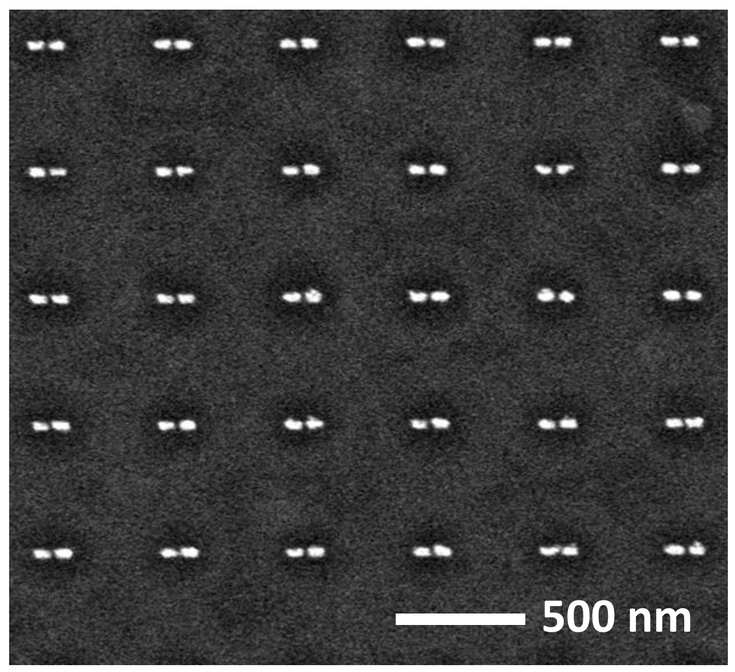

Figure 3 SEM of gold dimer antenna on MoS_2.

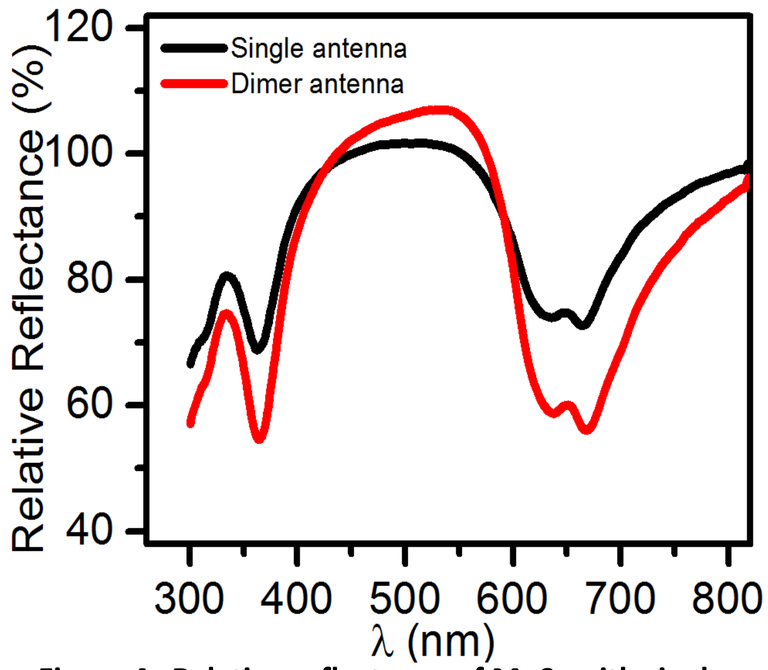

Figure 4 Relative reflectance of MoS_2 with single or dimer antenna compared with pristine MoS_2

Conclusion

Gold single antenna and dimer antenna were fabricated by electron beam lithography on monolayer MoS_2 which was grown by chemical vapor deposition. The SEM image shows the controllable distribution of gold antenna on MoS_2. The relative reflectance confirms that the well designed gold antenna has strong resonance at 660 nm which increased the scattering of light emitted by MoS_2, as a result, enhancing the photoluminescence of MoS_2 as shown in PL mapping and single spectrum.

References

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