Photoluminescence Properties of MoS_2 on h-BN/Au Heterostructure

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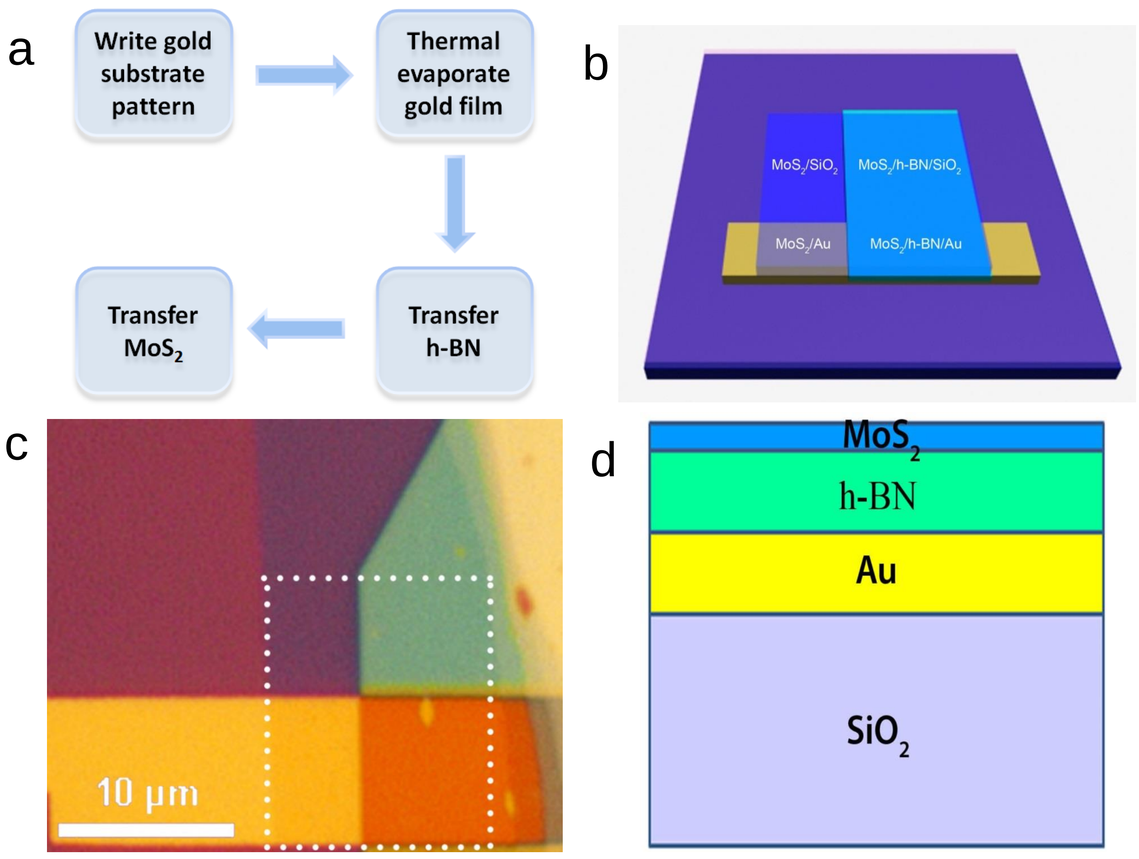
Abstract

Two-dimensional transition metal dichalcogenides (TMDs) are an emerging group of materials suitable for optoelectronic applications because of their large bandgap related to graphene. When the layer number decreases from bulk to monolayer, their photoluminescence (PL) is greatly enhanced due to an indirect to direct bandgap transition. There are many methods for enhancing the PL of TMDs, such as surface plasma of noble metal nanoarray, reducing the number of trions and defect sites by chemical doping, and choosing suitable substrates. The PL of MoS_2 is low compared to other TMDs due to n doping. Here we report a significant PL enhancement of MoS_2 on h-BN/Au heterostructure. The PL intensity saturation as the laser power is also observed. Such large enhancement is attributed to reduced n doping and field enhancement related mechanisms in this heterostructure.

Introduction

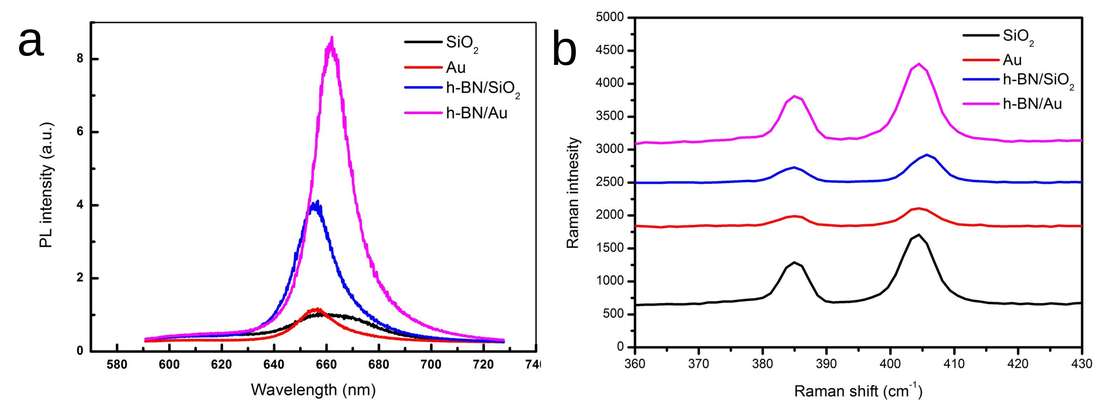
Monolayer two-dimensional (2D) transition metal dichalcogenides (TMDs) are an emerging group of materials suitable for electronic and optoelectronic applications because of their large direct bandgap compared to graphene[1]. The large choice of TMD bandgaps and the predicted type Ⅱ alignment nature[2] offer myriad possibilities of fabricating vertical and lateral hybrid structures for photovoltaic[3], photodetector[4] and light emission[5] applications. The optical properties of monolayer TMDs are dominated by excitons with much stronger binding energies than conventional semiconductors[6]. The PL of MoS_2 is low compared to other TMDs. So the PL enhancement of MoS_2 is studied here.

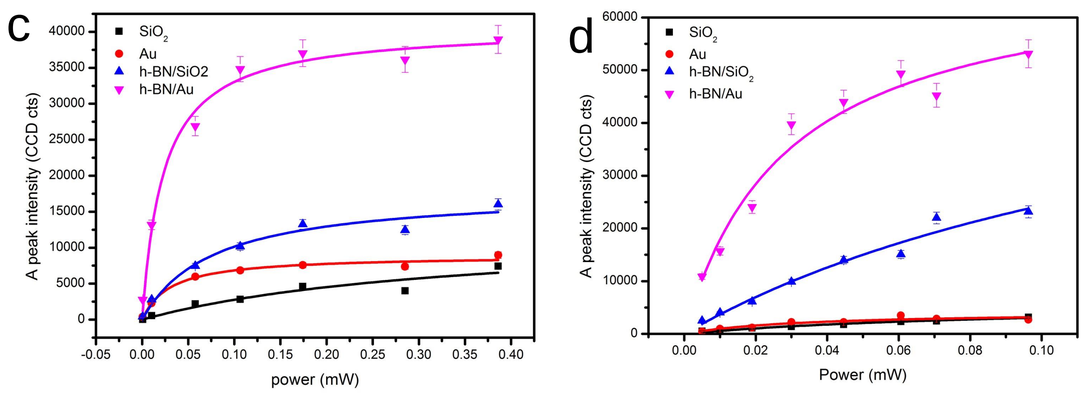
Methods



(**a**)The schematic diagram of the device fabrication process. (**b**) Schematic diagram and (**c**) the real optical picture of the hybrid structure. The white dashed region is the area where PL and Raman data are collected. (**d**)The cross section diagram of the MoS_2/h-BN/Au/SiO_2structure.

Results





(**a**) PL spectra of MoS_2 on SiO_2 (black), Au (red), h-BN/SiO_2 (blue), h-BN/Au (magenta) substrates. The PL spectra on four different substrates were normalized to the PL peak intensity of MoS_2 on SiO_2. The PL spectra were collected with 532 nm laser, 0.01mw, spot diameter 0.5 um. (**b**) Raman spectra of MoS_2 on SiO_2, Au, h-BN/SiO_2 and h-BN/Au structures. The Raman spectra were collected with 532 nm laser, 0.657mw, spot diameter 0.5um. (**c**) MoS_2 PL power dependence of 532 nm laser. (**d**) MoS_2 PL power dependence of 633 nm laser.

Conclusions

The PL intensity of MoS_2 on h-BN/Au heterostructure is greatly enhanced compared to that on SiO_2. Such large enhancement is attributed to reduced n doping and field enhancement related mechanisms on this heterostructure.

References

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