The currently adopted research strategy is to explore surface plasmonic resonance of AuNPs as the mechanism to enhance light absorption of MoS_2 nanosheets. Our recent results about AuNPs/ MoS_2 hybrid photocatalysts are shown in Figure 1. Figure 1A shows the high-resolution TEM (HRTEM) image of dispersed AuNPs with crystalline structures; the measured d-spacing is around 0.23 nm which accords to the (111) spacing of Au single crystals. Furthermore, the crystalline lattices with interlayer d-spacing equal to 0.65 nm has been observed also, and thus, the 2H crystalline form of MoS_2 is recognized to directly grow on AuNPs.

For the dispersion of gold nanoparticles shown on Figure 1B, various statistic distribution curves of separation distances are shown on Figure 1C, which confirm the effects of selected concentrations of dispersion agent polyvinylpyrrolidone (PVP) and the growth of MoS_2 nanosheets on reachable degree of spatial separation between AuNPs, and the average separation distances are estimated to be 1.25 nm, 2.75 nm, and 9.75 nm respectively. For the solutions with stable dispersion of AuNPs, the absorption peak at the wavelength of 525 nm has been commonly observed, which characterizes the occurrence of LSPR (local surface plasmon resonance). When the average separation distances among gold nanoparticles decreases to around 1.25 nm, there is an extra broad absorption peak ranging from 525 nm to 800 nm wavelength (Figure 1D), indicating the reduction of energy bandgaps of Au crystals upon the occurrence of LSPR. According to above results, the occurrence of LSPR, and corresponding dependence on the separation distances among AuNPs has been realized.

As shown on Figure 1E, the original photoluminescence (PL) spectrum of AuNPs (pink line) is significantly modified by the growth of MoS_2 nanosheets; the light emission around 553 nm and 750 nm under the excitation of 325 nm laser is almost absent after the growth of MoS_2 nanosheets (red line). Accordingly, efficient electron transfer from AuNPs to MoS_2 nanosheets has been inferred. However, with further decrease of separation distances between AuNPs from 9.75 nm, the PL intensities of the solutions with stable dispersion of MoS_2/AuNPs increase. Accordingly, the electron transition from AuNPs to MoS2 nanosheets is known to be highly dependent on the separation between AuNPs and critically subject to activated local surface plasmonic resonance. The adjustment of LSPR effects on electron transition has not been realized before, and we will further design more research approaches to fully decipher this phenomenon.

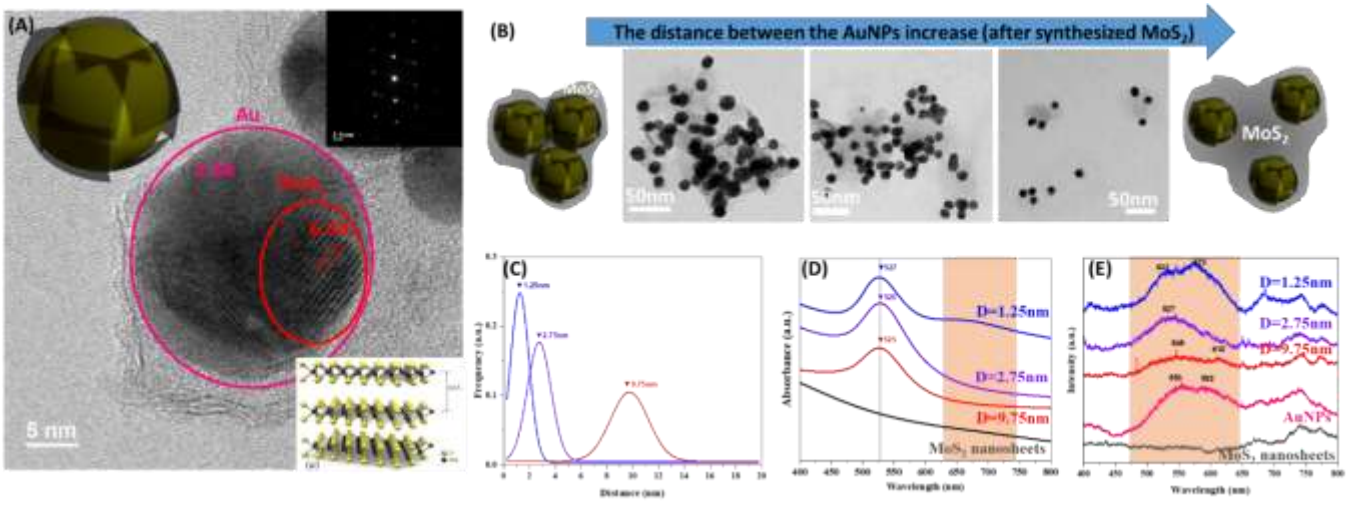

Figure 1. (A) HRTEM picture of MoS_2 grew on AuNPs, (B)The TEM pictures of different separation of AuNPs within MoS_2 nanosheets, (C) The Gauss distribution of different separation of AuNPs within MoS_2 nanosheets, (D) UV-Vis spectrum for different spacing of AuNPs within MoS_2 nanosheets, (E)PL spectrum for different spacing of AuNPs within MoS_2 nanosheets.