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# Ultrathin gold film modified optical properties of excitons in monolayer $MoS_2$

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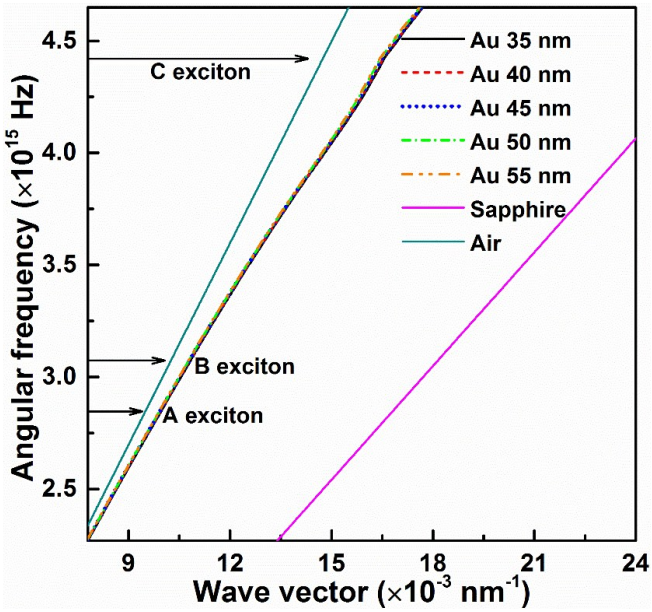


**Fig. S1** Dispersion curves of monolayer $MoS_2$-Au hybrid films. The thickness of gold film changes from 35 to 55 nm. The horizontal arrows indicate the positions of A, B and C excitonic resonance frequencies. For reference, photon dispersion curves of sapphire and air are also shown. Note that the imaginary part of wave vector $k_x$ is neglected since it is smaller by more than 15 orders of magnitude than the real part.

It should be noted that the wave vector of dispersion curve increases as the gold film increases in thickness from 0 to 19 nm, and the wave vector for C exciton is a little larger than $17 \times 10^{-3}$ nm$^{-1}$ when the gold film reaches thickness of 19 nm (cf. Fig. 4). Nevertheless, the calculated wave vector of dispersion curve in Fig. S1 slightly decreases as the thickness changes from 35 to 55 nm, and the wave vector for C exciton is smaller than the value of $17 \times 10^{-3}$ nm$^{-1}$. This discrepancy might partly be attributed to the utilized dielectric constants. In Fig. 4, the gold film thicknesses are below 20 nm and the dielectric constants are measured by ellipsometer (refer to Ref. 15). In Fig. S1, the gold film thickness changes from 35 to 55 nm and the dielectric constants are calculated via the Drude model

(refer to Refs. 10, 32). As proved by Ref. 15, the magnitudes of both the real and imaginary parts of dielectric constant mainly increase as the gold film thickness increases from 2.4 to 19 nm. However, when the gold film is 40 nm in thickness, the magnitude of real part is a little smaller than that of the 19 nm Au film. This opposite tendency of dielectric constant may explain the opposite trend observed in the dispersion curves. Besides, the dielectric constants calculated via the Drude model for thick gold films do not change with the gold film thickness. Thus we deduce that if the dielectric constant of gold film is fixed, only increasing the gold film thickness may induce a slight decrease of the wave vector.

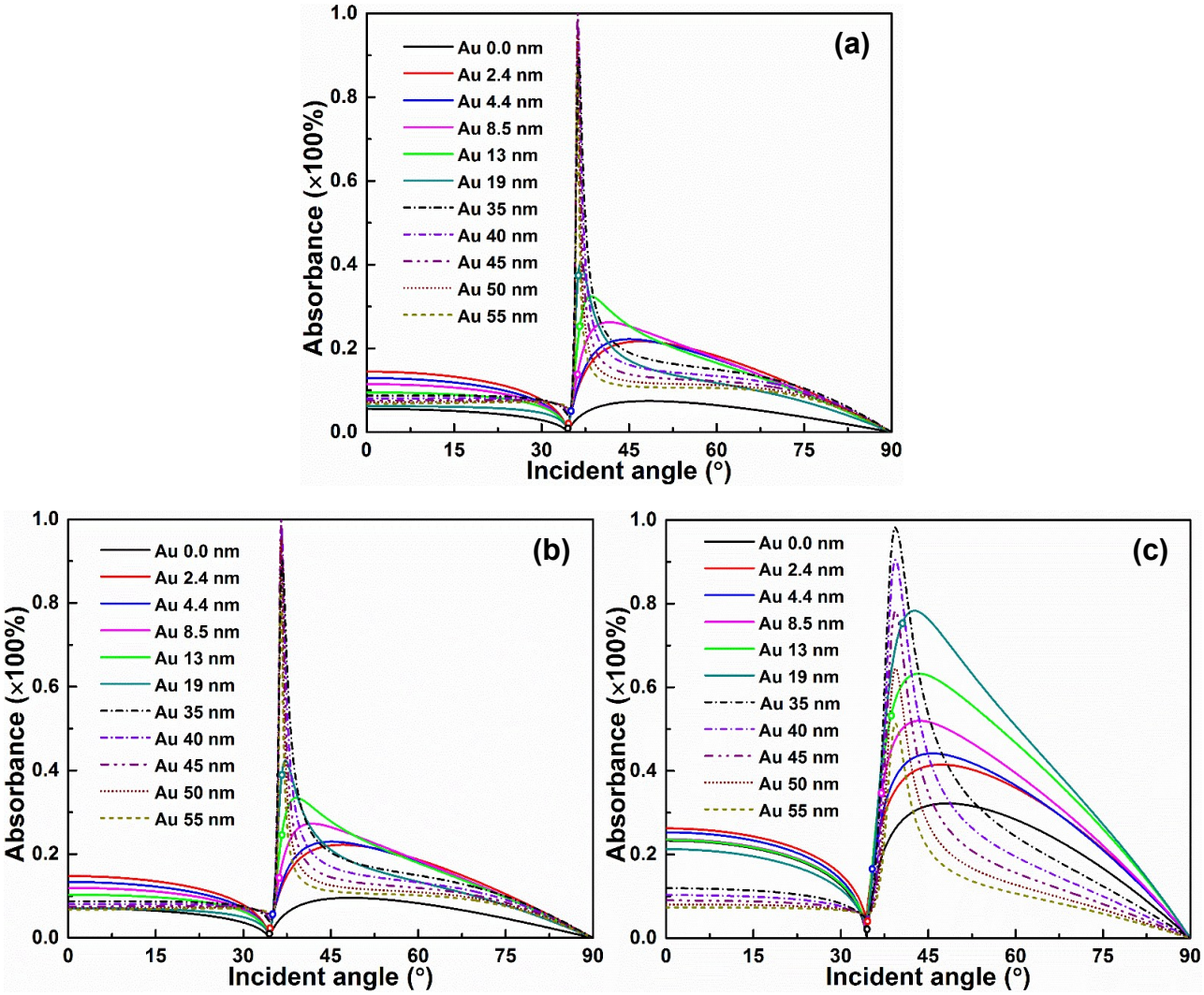


**Fig. S2** Variation of absorption with respect to incident angle for hybrid structures consisting of monolayer $MoS_2$ and different thicknesses of gold films. (a), (b) and (c) correspond to A, B and C excitonic resonance wavelengths, respectively. Open circles indicate the positions of respective SPR angles. For gold films above 19 nm in thickness, the SPR angle matches with the incident angle of maximum absorption such that the corresponding open circles are not shown.

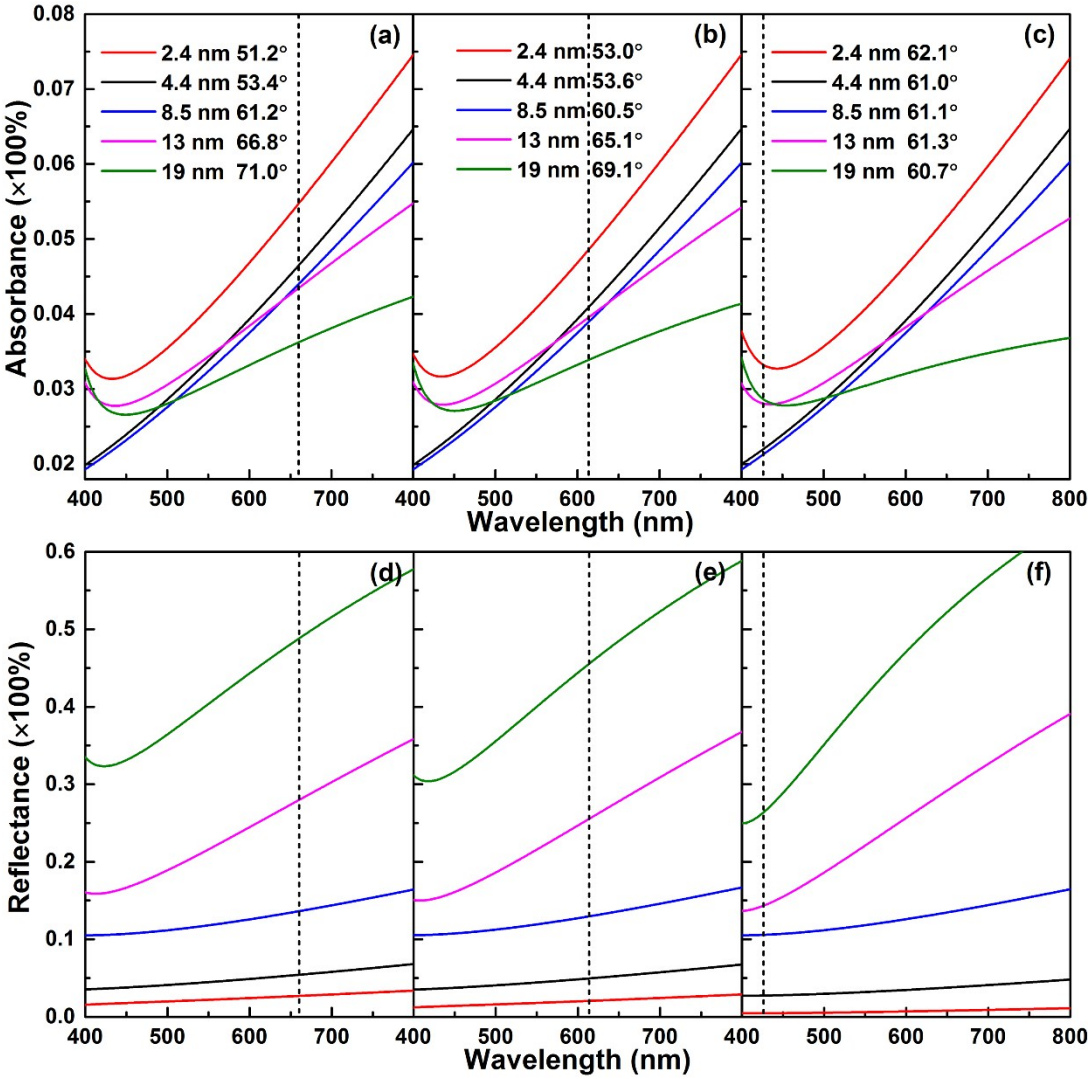


**Fig. S3** (a-c) Absorption and (d-f) reflection spectra of different thicknesses of pure gold films for the external reflection. Dashed vertical lines indicate the positions of A, B and C excitonic resonance wavelengths. Thicknesses of gold films as well as their corresponding incident angles (matching with the values of $\theta_{m,A}$, $\theta_{m,B}$ and $\theta_{m,C}$ in Fig. 6b) are shown in the legends of (a-c).