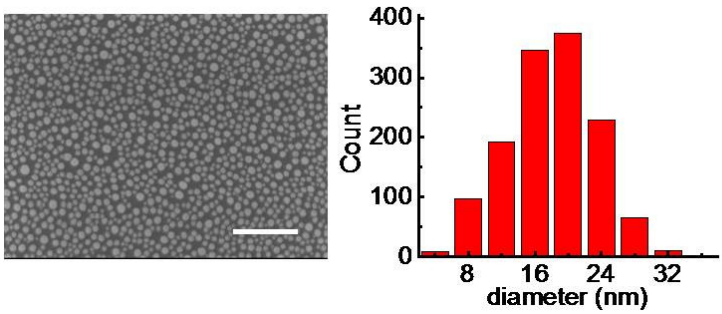
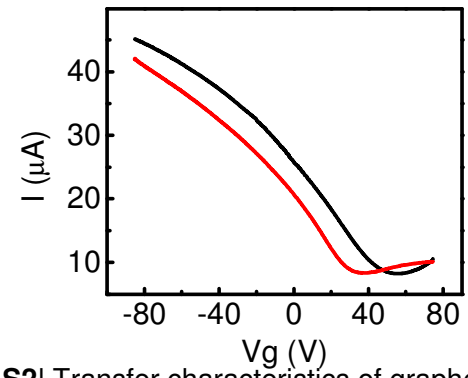
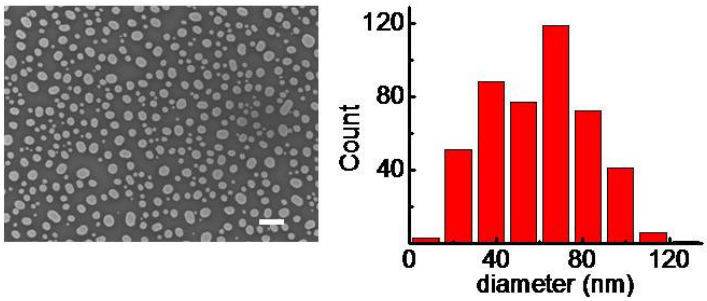
Supplementary Information



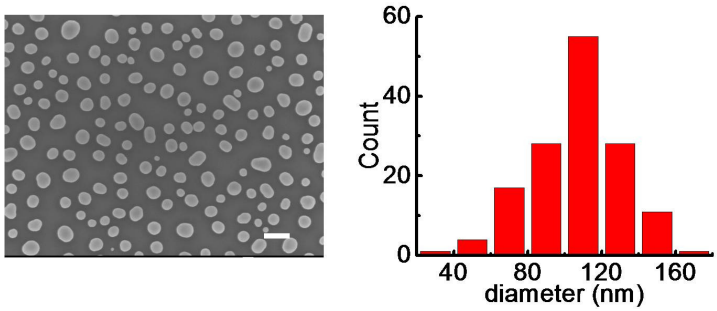
Supplementary Figure S1| (left) SEM image and of the Au nanoparticles obtained by annealing 4-nm thick gold thin film. The scale bar in SEM image is 200 nm. (right) Size distribution histogram with an average diameter of 18 nm and a particle density of 1320/μm^2.



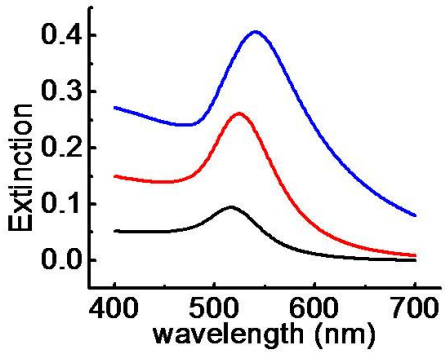
Supplementary Figure S2| Transfer characteristics of graphene before ((black line) and after (red line) transferring gold nanoparticle thin film. Electrical property of graphene is well kept after transferring process with a little n-doping (Dirac point shifts to negative direction). The mobility of the back-gated device can be determined by the equation: $\mu=[dI_{ds}/dV_g]\times[L/WC_iV_{ds}]$, where L is the channel length, W is the channel width, C_i is the capacitance between the channel and back gate per unit area. The carrier mobility was determined to be 1140 cm^2/Vs before transferring and 1280 cm^2/Vs after transferring gold nanoparticles, highlighting the transferring process and gold nanoparticles don't produce any obvious impact on the charge transport in graphene.



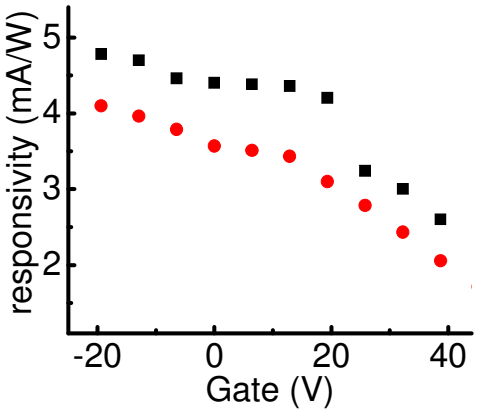
Supplementary Figure S3| (left) SEM image and of the Au nanoparticles obtained by annealing 8-nm thick gold thin film. The scale bar in SEM image is 200 nm. (right) Size distribution histogram shows an average diameter of 60 nm and a particle density 76/μm^2.



Supplementary Figure S4| (left) SEM image and of Au nanoparticles obtained by annealing 12-nm thick gold thin film. The scale bar in SEM image is 200 nm. (right) Size distribution histogram shows an average diameter of 110 nm and a particle density 28/μm^2.



Supplementary Figure S5| Extinction spectra of 18-nm, 60-nm and 110-nm diameter nanoparticle array on graphene. Compared with 18-nm particles (black line, ~21% extinction at 530 nm), the 60-nm nanoparticle array shows a little red-shift peak and an overall peak extinction of ~45% (red line), and 110-nm nanoparticle array show a more red shift and ~61% peak extinction(blue line).



Supplementary Figure S6| Photo-responsivity as a function of back gate voltage for two plasmon resonance enhanced photodetectors (black square for device 1 and red diamond for device 2). The responsivity can be greatly reduced by applying a positive gate voltage. On other hand, the responsivity can also be increased by applying a negative gate voltage, however, to much a smaller degree. We believe this is because that our graphene device is relatively highly p-type doped intrinsically, and applying of additional negative gate voltage would only have limited ability to increase the potential barrier.