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# **Supplementary information**

Plasmon Resonance Enhanced Colloidal HgSe Quantum Dots Filterless Narrowband Photodetectors for Mid-wave Infrared

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- 2. The experimental setup for photoresponse measurement.
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### 1. Effects of disk radius and periodic distance on resonance wavelength

We performed simulation to study the effect of changes of nanodisk radius *R* on resonance wavelength. In the simulation, the periodic distance is kept to be 2  $\mu$ m while the radius is changed from 0.4  $\mu$ m to 0.7 $\mu$ m. The results show resonance wavelength at 4.1  $\mu$ m, 4.2  $\mu$ m, 4.2  $\mu$ m and 4.2  $\mu$ m, respectively (See Fig. S1). The resonance wavelength almost reveals no shift. On the contrary, when the radius is kept to be 0.5  $\mu$ m, the changes of periodic distance *P* cause large shift of resonance wavelength (See Fig. S2). This is consistent with previous studies <sup>1-4</sup>.



Fig. S1. The effect of changes of nanodisk radius *R* on resonance wavelength



Fig. S2. The effect of changes of nanodisk periodic distance P on resonance wavelength

## 2. The experimental setup for photoresponse measurement.

Item	Values	Remarks
Area of the source	$5.06 \text{ cm}^2$	Circle with diameter of 2.54 cm
Filter transmission	0.7~0.9	
Distance from source to sample	20 cm	
Temperature of blackbody	1200 °C	
Area of detector	200 μm ×200 μm	
Optical power on the detector	0.8µW to 30 µW	See Fig. S3a; Detailed calculation is
		explained as below
Measured photocurrent		See Fig. S3b

Details of the experimental setup for the photoresponse are summarized in Table S1.

Table S1. The summary of key parameters of the experimental setup.



Fig. S3. (a) The optical power illuminated on the detector. (b) The measured spectral photocurrents for the four samples. (c) The experimental setup for photoresponse measurement.

#### Calculation of the optical power on the detector:

A blackbody system is used as the light source as shown in Fig S4c. The spectral irradiance from the blackbody can be calculated by the following equation:

$$W_{\lambda} = \frac{C_1}{\lambda^5 (e^{(C_2/\lambda T)} - 1)},$$
(1)

Where  $C_1$  is first radiation constant (3.7415×10<sup>4</sup>Wµm<sup>4</sup>/cm<sup>2</sup>),  $\lambda$  is the wavelength in micron (µm),  $C_2$  is the second radiation constant (1.43879×104 µmK), *T* is the temperature of a blackbody in Kelvin, and *e* is the Naperian base.

The optical power (P) incident on a detector's sensing area is defined as:

$$P = A \times W \frac{a^2}{4d^2} t \times \alpha , \qquad (2)$$

where *A* is the detector area, *W* is radiant emittance of infrared source, *a* is the diameter of area of the source and it's 2.54 cm, *d* is the distance from the aperture plane to the sensing area and it's 20 cm, *t* is the transmission of the optical path (0.7-0.9) and  $\alpha$  is the amplification factor of optical power due to the concentration by the lens (~6).

## 3. The temporal photoresponse of the HgSe CQDs photodetectors.

The temporal photoresponse of the HgSe CQDs based photodetectors were measured as shown in Fig. S4. Based on the temporal photoresponse, the response time and RMS noise were extracted.

#### Response time:

The measured rise and fall time are 1.2 s and 2.1 s, respectively as shown in Fig. S4a. The rise time is defined as the time required for a pulse to rise from 10 percent to 90 percent of its steady value, and the fall time is defined as the time required for a pulse to decrease from 90 percent to 10 percent of its steady value.

## RMS noise:

The signal noise is characterized by RMS noise. The calculated RMS noise currents are typically in the range of  $3\sim10$  nA, depending on the bias voltages and HgSe CQDs samples. And the metal nanostructures showed no significant influence on the noise level. As shown in the Fig. S4a and b, the RMS noise current  $I_{RMS}$  of HgSe film without and with plasmonic disks are 3.1 nA and 3.26 nA, respectively.



Fig. S4. (a) The temporal response of HgSe CQDs film without plasmonic disks. (b) The temporal response of HgSe CQDs film with plasmonic disks.

## 4. Photoresponse of "9.0 µm sample" with detuned nano-disk array.

"9.0  $\mu$ m samples" are added onto two different disk arrays with resonance wavelengths of 6.4  $\mu$ m and 7.2  $\mu$ m. The photoresponse was then measured as shown in Fig. S4. The blue curve is the photoresponse from "9.0  $\mu$ m sample" without the disk array, as reference results. Beside the peak at 9.0  $\mu$ m (from the intraband transition), obvious enhanced photoresponse at 6.4 $\mu$ m and 7.2  $\mu$ m was found, due to the addition of disk array. The photoresponses were normalized by the value of photoresponse at 9 $\mu$ m for clarity.



Fig. S5. The photoresponse of "9.0  $\mu$ m sample" combined with disk array with center wavelength of (a) 6.4 $\mu$ m and (b) 7.2  $\mu$ m.

#### 5. Optical absorption of HgSe CQDs film with and without nano-disk array.

The HgSe CQDs film partially absorbs the incident IR. The absorption of the HgSe CQDs film is experimentally measured to be ~ 12.8% at the peak wavelength. For HgSe CQDs film with metal patterns, the peak absorption increases to ~ 22.2 %. The corresponding measurement results are shown in Fig. S6.



Fig. S6. The measured optical absorption of CQDs sample with and without disk array.

### Reference

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