Electronic Supplementary Information

Extinction, absorption, and scattering of light by plasmonic spheres embedded in an absorbing host medium

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Section S1. Derivation of IEA polarizability β^{IEA}

To obtain the IEA polarizability, we apply the general method developed by Le Ru *et al.* [1]. In this method, the radiative correction to the generalized polarizability is introduced through the reactance matrix $\mathbf{K}$, which is related to the known T-matrix [2] $\mathbf{T}$ by the following relation [1]:

$$\mathbf{T}^{-1} = -i\mathbf{K}^{-1} - \mathbf{1}, \tag{S1}$$

The T-matrix method [2] provides an exact solution to the EM scattering problem. Beyond EA, the *T*-matrix itself can be considered a generalization of the concept of polarizability to higher orders [1]. For example, the lowest-order T-matrix elements for spheroids $T^{22}_{11,m=0}$ and $T^{22}_{11,m=1}$ correspond to the dipolar polarizabilities along the symmetry axes. For spheres, the T-matrix is completely diagonal [2] and its elements are proportional to the Mie scattering coefficients. According to Eq. (39) of Ref. [1], we define the generalized polarizability through the lowest order T-matrix element T^{22}_{11}

$$\beta^{IEA} = -\frac{3i}{2x_1^3} T^{22}_{11}, \tag{S2}$$

or, equivalently, through the lowest order K-matrix element K^{22}_{11}

$$\beta^{IEA} = \frac{3}{2x_1^3} \frac{K^{22}_{11}}{1 - iK^{22}_{11}}, \tag{S3}$$

where

$$T^{22}_{11} = -\frac{P^{22}_{11}}{Q^{22}_{11}}, \tag{S4a}$$

$$K^{22}_{11} = -\frac{P^{22}_{11}}{U^{22}_{11}}. \tag{S4b}$$

The explicit expressions for P^{22}_{11}, Q^{22}_{11} and U^{22}_{11} read

$$P^{22}_{11} = (n_2 / n_1)\psi'_n(x_1)\psi_n(x_2) - \psi_n(x_1)\psi'_n(x_2) \tag{S5}$$

$$Q^{22}_{11} = \xi_n(x_1)\psi'_n(x_2) - (n_2 / n_1)\xi'_n(x_1)\psi_n(x_2) \tag{S6}$$

$$U^{22}_{11} = \chi_n(x_1)\psi'_n(x_2) - (n_2 / n_1)\chi'_n(x_1)\psi_n(x_2) \tag{S7}$$

where $\xi_n(z) = \psi_n(z) + i\chi_n(z)$ are the Riccati–Bessel functions of a complex argument z. Note that here we have generalized the derivation and formulae of Ref. [1] to the case of absorbing host. Inserting (S5) and (S6) into Eq. (S4a) gives

$$T^{22}_{11} = -a_1, \tag{S8}$$

where a_1 is the first electric Mie coefficient. It can be easily verified that the substitution of expressions (S5) and (S7) in (S4b) results in a particular form of general relation (S1). After substitution of Eq. (S8) in Eq. (S2), we get the final result

$$\beta^{IEA} = \frac{3i}{2x_1^3} a_1 . \tag{S9}$$

This coincides with Eq. (28) of the main text.

Section S2. Size-corrected dielectric function of plasmonic nanoparticles and optical constants of bulk gold

The size-corrected dielectric functions of small plasmonic particles can be represented as

$$\varepsilon_p(\omega, l_{eff}) = \varepsilon_b(\omega) + \Delta\varepsilon(\omega, l_{eff}), \tag{S10}$$

with the Lorentz–Drude correction [3] to the tabulated bulk value $\varepsilon_b(\omega)$:

$$\Delta\varepsilon(\omega, l_{eff}) = \frac{\omega_p^2}{\omega^2 + i\omega\gamma_b} - \frac{\omega_p^2}{\omega^2 + i\omega(\gamma_b + \gamma_p)}, \tag{S11}$$

where $i = \sqrt{-1}$, ω_p is the plasma frequency; γ_b is the damping constant of bulk Au; l_{eff} is the effective path length of the electrons; and $\gamma_p = \gamma_p(l_{eff})$ takes into account three possible contributions from radiation damping [4], surface-electron scattering [5], and chemical interface damping (CID):[6, 7]

$$\gamma_p = \gamma_p^{rad} + \gamma_p^{surf} + \gamma_p^{CID} . \tag{S12}$$

For small spheres of a radius R, Eq. (S12) can be rewritten as

$$\Delta\varepsilon(\omega, l_{eff}) = \frac{\omega_p^2}{\omega(\omega + i\gamma_b)} - \frac{\omega_p^2}{\omega(\omega + i\gamma_s)}, \tag{S13}$$

where

$$\gamma_s = \gamma_b + A_s v_F / R, \tag{S14}$$

is the damping parameter, the damping constant A_s includes all possible mechanisms of the surface electron scattering and the chemical interface dumping contributions. In Eq. (S15), the effective path length of the electrons was set to be $l_{eff} = R$. Coronado and Schatz [8] discussed geometrical models to evaluate l_{eff} for particles of different shapes. The separation of Eq. (S13) into real and imaginary parts gives

$$\Delta\varepsilon(\omega, l_s) = \frac{\omega_p^2}{\omega^2}\left[\frac{1}{(1+\gamma_b^2/\omega^2)} - \frac{1}{(1+\gamma_s^2/\omega^2)}\right] + i\frac{\omega_p^2}{\omega^2}\left[\frac{\gamma_s/\omega}{(1+\gamma_s^2/\omega^2)} - \frac{\gamma_b/\omega}{(1+\gamma_b^2/\omega^2)}\right]. \tag{S15}$$

Under conditions $\gamma_s^2/\omega^2 << 1$, $\gamma_b^2/\omega^2 << 1$, we arrive at:

$$\Delta\varepsilon(\omega, l_s) = \left|\Delta\varepsilon''\right|\left(\frac{\gamma_s + \gamma_b}{\omega} + i\right), \tag{S16}$$

$$\left|\Delta\varepsilon''\right| = \frac{\omega_p^2}{\omega^3}\left[\gamma_s - \gamma_b\right] = \frac{\omega_p^2}{\omega^3} A_s \frac{v_F}{R} = \frac{\lambda^3}{2\pi c \lambda_p^2} A_s \frac{v_F}{R}, \tag{S17}$$

where $\lambda_p = 2\pi c/\omega_p$ is plasma wavelength, c is the speed of light. Eq. (S16) can be normalized as follows

$$\left|\Delta\varepsilon''\right| = \frac{\lambda^3}{2\pi c \lambda_p^2} A_s \frac{v_F}{R} = 5.37(\text{nm}) \frac{A_s}{R(\text{nm})}\left(\frac{\lambda}{520}\right)^3, \tag{S18}$$

where the wavelength is expressed in nm and normalized to the LPR wavelength of small gold spheres in water.

Table 1 summarizes the literature data for bulk parameters of gold. The average value of plasma frequency is $\hbar\omega_p = 9.0 \pm 0.38$ eV. In Table 1, the damping constant $\gamma_b = 1.64 \times 10^{14}\,\text{s}^{-1}$ seems to be overestimated compared with other literature data. The average value of the damping constant equals $\gamma_b = (1.02 \pm 0.17) \times 10^{14}\,\text{s}^{-1}$, where the first value has not been taken into account.

Table S1. Parameters of the Lorenz-Drude model for bulk gold

$\hbar\gamma_b$ eV	γ_b $10^{14}\,\text{s}^{-1}$	$\hbar\omega_p$ eV	ω_p $10^{16}\,\text{s}^{-1}$	λ_p nm	Refs.
0.108	1.64	8.85	1.34	140	[9]
0.0708	1.08	9.48	1.37	138	[10]
0.0708	1.08	9.48	1.44	131	[11]
0.0691	1.05	8.95	1.36	139	[12]
0.0829	1.26	8.71	1.32	143	[13]
0.047* 0.055**	0.714* 0.833**	8.45	1.28	147	[14]
0.053	0.803	9.07	1.38	137	[15]

*TS sample; **SC sample[14]

Optical constants of bulk gold for 300-2300 nm

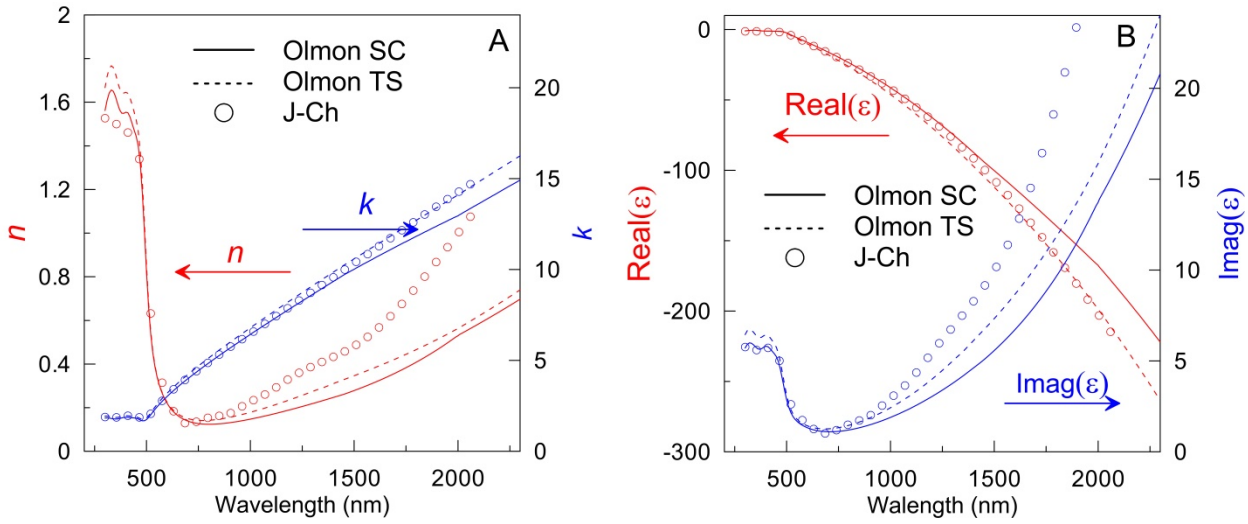

Figure S1. Spectral dependencies of the complex refractive index (A) and the dielectric function (B) by a cubic spline interpolation (solid lines) of tabulated data by Johnson and Christy[10] and Olmon *et al*. [14] (TS and SC samples; see FORTRAN subroutine Olmon below). Note significant differences between Johnson and Christy and Olmon *et al*. data for wavelengths larger than 1000 nm.

FORTAN subroutine for spline calculating Real (n) and Imag (n) of bulk gold and size-corrected optical constants ref=n, eps=n^2

```
subroutine Olmon(wavel,R,ref,eps,KD,KS)
      IMPLICIT REAL*8(A-H,O-Z)
      REAL*8 MN,MK
      DIMENSION XN(1000),YN(1000),MN(1000),XK(1000),YK(1000),MK(1000)
      complex*16 ref, eps,epsb,Deps,aim

C     wavelength wavel and radius R shold be given in nm
C     ref and eps are the output parameters:
C     the size-corrected complex refractive index and dielectric function, respectively
C     the parameter KD=0, 1, 2 defines the size-correction options (see below)
C     the parameter KS=0, 1 defines the type of Au sample in Olmon et al. measurements
C     KS=0 correspondts to the TS sample, KS=1 corresponds to the SC sample
C     aim=csqrt(-1.)
      aim=(0.d0,1.d0)
C     N=258 is the number of interpolation points
      N=258
C     wavel is the wavelength in vacuum in nm
      xx=wavel

      xn(1)=299.9859497
      xn(2)=310.037992
      xn(3)=320.0417992
      xn(4)=330.0084988
      xn(5)=339.9621415
      xn(6)=350.0400706
      xn(7)=360.0005604
      xn(8)=369.9916234
      xn(9)=379.9699448
      xn(10)=390.010044
      xn(11)=399.9490097
      xn(12)=410.0006382
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xn(13)=420.0006538
xn(14)=430.0526986
xn(15)=439.972296
xn(16)=450.0333684
xn(17)=460.0526642
xn(18)=469.9931501
xn(19)=480.0007472
xn(20)=490.0560988
xn(21)=499.9362621
xn(22)=510.0131345
xn(23)=520.0679237
xn(24)=530.0735058
xn(25)=540.0008406
xn(26)=550.0629681
xn(27)=560.0008717
xn(28)=570.0422667
xn(29)=579.9073573
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xn(31)=600.1171007
xn(32)=609.858303
xn(33)=619.920965
xn(34)=630.0009807
xn(35)=640.0835983
xn(36)=650.1530834
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xn(42)=710.1041982
xn(43)=720.0011208
xn(44)=730.1778151
xn(45)=740.2041373
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xn(47)=760.1728571
xn(48)=770.0881553
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xn(50)=790.2115551
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xn(55)=840.0013076
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xn(61)=899.7401524
xn(62)=910.3097871
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xn(64)=930.113976
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xn(66)=950.0704444
xn(67)=960.3732998
xn(68)=970.1423552
xn(69)=980.1121976
xn(70)=990.2890815
xn(71)=999.8725242
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xn(77)=1059.693957
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xn(80)=1090.450246
xn(81)=1100.125936
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xn(83)=1120.001743
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xn(129)=1650.042494
xn(130)=1659.98384
xn(131)=1670.045703
xn(132)=1680.002615
xn(133)=1690.078967
xn(134)=1700.043782
xn(135)=1709.890953
xn(136)=1720.091468
xn(137)=1729.931533
xn(138)=1739.88483
xn(139)=1749.953324
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xn(142)=1780.103274
xn(143)=1790.126956
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xn(145)=1809.988219
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      xn(255)=2959.756338
      xn(256)=2973.242038
      xn(257)=2986.851192
      xn(258)=3000.585503
C
      do i=1,N
      xk(i)=xn(i)
      end do
C
      if(KS.eq.0) then
C     TS sample Spline  parameters Real n

      yn(1)=1.667
      yn(2)=1.719
      yn(3)=1.754
      yn(4)=1.767
      yn(5)=1.759
      yn(6)=1.732
      yn(7)=1.696
      yn(8)=1.664
      yn(9)=1.645
      yn(10)=1.642
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      yn(15)=1.556
      yn(16)=1.52
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      yn(18)=1.372
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      yn(34)=0.1874
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c     k=Imag n
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      yk(3)=1.825
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C
      end if

      J=2
10    IF (XX.LE.XN(J)) GO TO 20
      J=J+1
      GO TO 10
20    I=J
      XN0=XN(I)-XX
      XN1=XX-XN(I-1)
      H=XN(I)-XN(I-1)
      H2=H*H/6.0
      refre=MN(I-1)*XN0*XN0*XN0/6./H+MN(I)*XN1*XN1*XN1/6./H+
      (YN(I-1)-MN(I-1)*H2)*XN0/H+(YN(I)-MN(I)*H2)*XN1/H
      J=2
30    IF (XX.LE.XK(J)) GO TO 40
      J=J+1
      GO TO 30
40    I=J
      XN0=XK(I)-XX
      XN1=XX-XK(I-1)
      H=XK(I)-XK(I-1)
      H2=H*H/6.0
       refim=MK(I-1)*XN0*XN0*XN0/6./H+MK(I)*XN1*XN1*XN1/6./H+
      (YK(I-1)-MK(I-1)*H2)*XN0/H+(YK(I)-MK(I)*H2)*XN1/H

            eps1b=refre*refre-refim*refim
            eps2b=2.d0*refre*refim
            epsb=eps1b+aim*eps2b
c     Correction to the size limiting effect
c     Step1: calculation of the bulk epsb=eps1b+i*eps2b
            eps1b=refre*refre-refim*refim
```

```
            eps2b=2.d0*refre*refim
             epsb=eps1b+aim*eps2b
      C-------------------------------------------------------
      c           SIZE CORRECTION
      c           gamma_b=gam_b*10**(14) 1/s, gam_b=1.05-1.6
      c           1.3 - Scaffardi JApplPhys 2014,(1.32) Etchegoin-Le Ru(2006)gam_b=1.3
      c            gam_b=1.3
      c           Olmon PRB 2012 gam_b=1.4
      c
                   gam_b=1.3
      c
      c           Plasma wavelength
      c           (h/2*pi)*omega_p=9 eV  lambda_p=140 nm
      c           Olmon PRB 2012 (h/2*pi)*omega_p=8.45 eV  lambda_p=131 nm
                   wp=140.
      c
      c           parameters gamma_b/omega and gamma_a/omega = [gamma_b+A*v_F/Leff]/omega
      c           a=1 v_F=14.1*10**(14) nm/s Fermi velocity, Leff=Rm effetive length
      c           gamma_b/omega=ga_om=0.53*10**(-4)*gam_b*lambda
      c           v_F/(Leff*omega)=7.48*10**(-4)*lambda/Leff

      c           if KD=0 Full correction is used
      c            Deps=(wavel/wp)**2*[ 1.d0/(1.d0+aim*gamb_om)-1.d0/(1.d0+aim*gama_om)]
      c           if KD=1 approximationm  Deps = Deps2*[B+ i] is used
      c           Deps2=(5.d0/Rm)*(wavel/520.d0)**3.d0
      c           B=(gama+gamb)/2/omega
      c           if KD=2, we set B=0
      c
                   gamb_om=0.53d-04*gam_b*wavel

                   gama_om=gamb_om+7.48d-04*wavel/Rm

      c           Step 2:
                  IF(KD.eq.0) then
      C           2.1 Calculation of the FULL coorection term

                  Deps=1.d0/(1.d0+aim*gamb_om)-1.d0/(1.d0+aim*gama_om)

                  Deps=(wavel/wp)**2*Deps

                  go to 60
                  end if

      c           Using approximationm for Deps = Deps2*[(gamma_a+gamma_b)/2/omega + i]
                  Deps2=(5.d0/Rm)*(wavel/520.d0)**3.d0
                  B=(1.06*gam_b+7.48/Rm)*1.d-04*wavel
                  if(KD.eq.2) then
                        B=0.
                  end if
                  Deps=Deps2*(B+aim)

      60          continue
      c     Step 3: Final correction
      eps=epsb+Deps
                  ref=cdsqrt(eps)
C-------------------------------------------------------------
      RETURN
      END
```

Section S3. Optical constants of bulk silver for 250-1450 nm

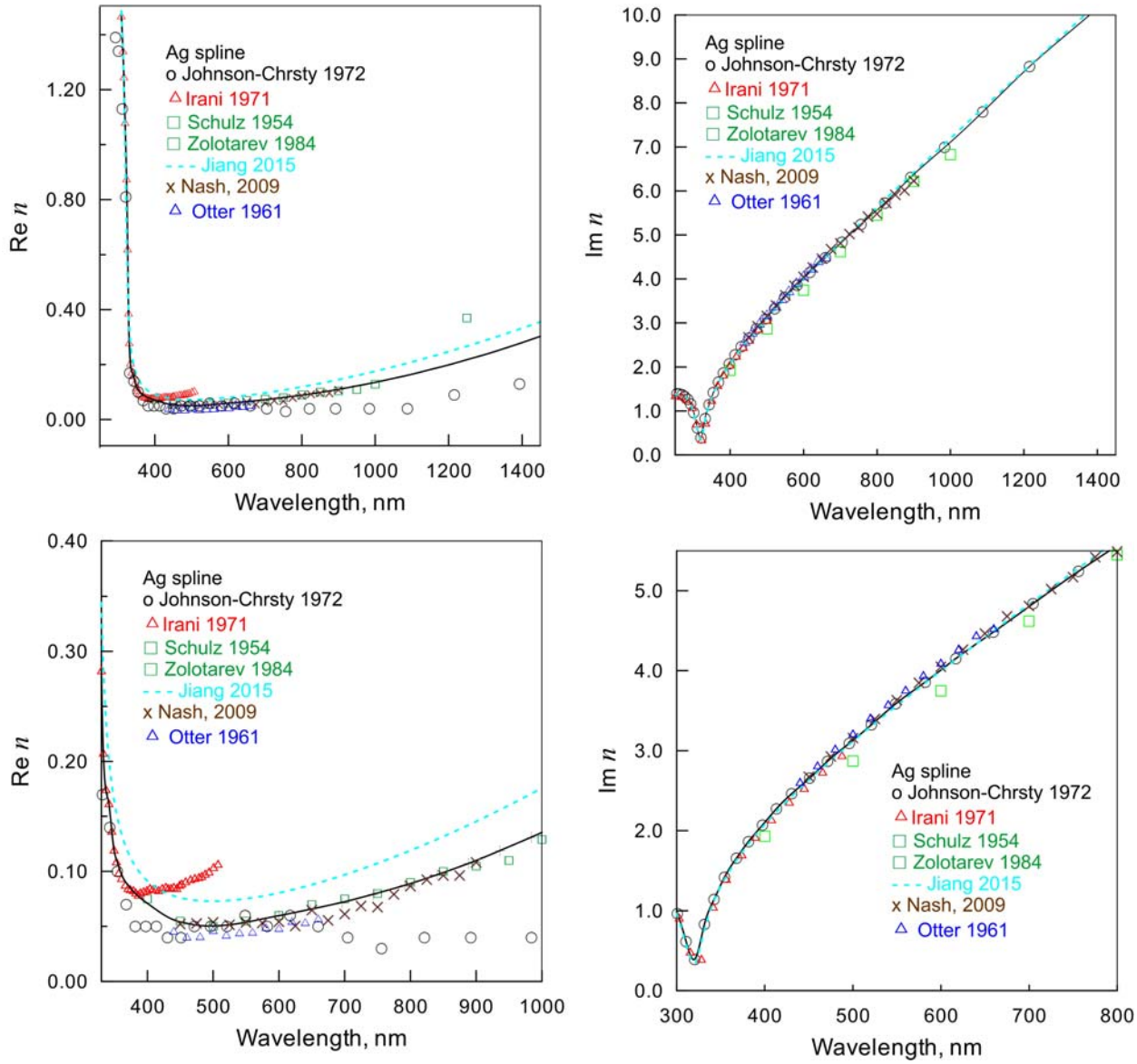

Figure S2. Optical constants of bulk silver taken from Refs.[10, 16-22]. The solid black line shows the average spline used in this work (see FORTAN subroutine below).

FORTAN subroutine for spline calculating the complex refractive index of bulk silver

```
subroutine Ag2021(wavel, Leff , ref, eps)
IMPLICIT REAL*8(A-H,O-Z)
Real*8 Leff
C       Leff=size/As is the effective scattering length of electrons
REAL*8 MN,MK
DIMENSION XN(100),YN(100),MN(100),XK(100),YK(100),MK(100)
complex*16 ref,eps,im
c       wavel is the wavelength in vacuum
xx=wavel
```

```
if(xx.gt.600) go to 1

C spline parameters
      XN(1)= 299.5
      XN(2)= 302.9
      XN(3)= 305.2
      XN(4)= 308.6
      XN(5)= 312.8
      XN(6)= 315.3
      XN(7)= 318.7
      XN(8)= 322.7
      XN(9)= 325.7
      XN(10)= 328
      XN(11)= 330
      XN(12)= 333
      XN(13)= 336.8
      XN(14)= 341.5
      XN(15)= 345.9
      XN(16)= 349.4
      XN(17)= 355
      XN(18)= 360
      XN(19)= 370
      XN(20)= 380
      XN(21)= 400
      XN(22)= 420
      XN(23)= 440
      XN(24)= 460
      XN(25)= 480
      XN(26)= 500
      XN(27)= 520
      XN(28)= 540
      XN(29)= 560
      XN(30)= 580
      XN(31)= 600
      XN(32)= 625
      XN(33)= 650
      XN(34)= 675
      XN(35)= 700
      XN(36)= 750
      XN(37)= 800
      XN(38)= 850
      XN(39)= 900
      XN(40)= 950
      XN(41)= 1000
      XN(42)= 1050
      XN(43)= 1100
      XN(44)= 1150
      XN(45)= 1200
      XN(46)= 1250
      XN(47)= 1300
      XN(48)= 1350
      XN(49)= 1400
      XN(50)= 1450
      XN(51)= 1500
      XN(52)= 1550
      XN(53)= 1600
C
      YN(1)= 1.564
      YN(2)= 1.556
      YN(3)= 1.543
      YN(4)= 1.47
      YN(5)= 1.343
      YN(6)= 1.248
      YN(7)= 1.083
      YN(8)= 0.877
      YN(9)= 0.622
      YN(10)= 0.389
      YN(11)= 0.282
      YN(12)= 0.207
      YN(13)= 0.174
      YN(14)= 0.161
      YN(15)= 0.136
      YN(16)= 0.119
      YN(17)= 0.107
      YN(18)= 0.098
      YN(19)= 0.088
      YN(20)= 0.081
```

YN(21)= 0.071
YN(22)= 0.0625
YN(23)= 0.056
YN(24)= 0.0528
YN(25)= 0.0508
YN(26)= 0.0505
YN(27)= 0.0512
YN(28)= 0.0528
YN(29)= 0.055
YN(30)= 0.0575
YN(31)= 0.0598
YN(32)= 0.0628
YN(33)= 0.0659
YN(34)= 0.0691
YN(35)= 0.0725
YN(36)= 0.0804
YN(37)= 0.089
YN(38)= 0.099
YN(39)= 0.11
YN(40)= 0.1225
YN(41)= 0.1355
YN(42)= 0.15
YN(43)= 0.165
YN(44)= 0.182
YN(45)= 0.199
YN(46)= 0.218
YN(47)= 0.237
YN(48)= 0.258
YN(49)= 0.28
YN(50)= 0.303
YN(51)= 0.3265
YN(52)= 0.352
YN(53)= 0.378

c

MN(1)= -9.877E-005
MN(2)= -9.877E-005
MN(3)= -0.007971
MN(4)= -0.001121
MN(5)= -0.002014
MN(6)= -0.00595
MN(7)= 0.00355
MN(8)= -0.01253
MN(9)= -0.01325
MN(10)= 0.03488
MN(11)= 0.008653
MN(12)= 0.0049
MN(13)= 0.001394
MN(14)= -0.001449
MN(15)= 0.0005294
MN(16)= 0.0008458
MN(17)= -0.0001715
MN(18)= 0.0001913
MN(19)= -8.268E-006
MN(20)= 2.173E-005
MN(21)= -1.057E-006
MN(22)= 4.999E-006
MN(23)= 1.106E-005
MN(24)= 2.58E-007
MN(25)= 5.907E-006
MN(26)= 1.613E-006
MN(27)= 2.642E-006
MN(28)= 1.318E-006
MN(29)= 1.087E-006
MN(30)= -1.166E-006
MN(31)= 5.777E-007
MN(32)= 5.315E-008
MN(33)= 1.697E-007
MN(34)= 2.281E-007
MN(35)= 8.379E-007
MN(36)= 1.233E-008
MN(37)= 7.928E-007
MN(38)= 1.765E-007
MN(39)= 9.014E-007
MN(40)= -1.82E-007
MN(41)= 1.027E-006
MN(42)= -3.245E-007
MN(43)= 1.471E-006
MN(44)= -7.612E-007
MN(45)= 1.573E-006

```
      MN(46)=  -7.324E-007
      MN(47)=  1.356E-006
      MN(48)=  1.074E-007
      MN(49)=  6.143E-007
      MN(50)=  -1.644E-007
      MN(51)=  1.243E-006
      MN(52)=  -8.651E-009
      MN(53)=  -8.651E-009
C
1     continue
C
      XK(1)=  248.9
      XK(2)=  255.2
      XK(3)=  261.6
      XK(4)=  268.9
      XK(5)=  276.1
      XK(6)=  284.4
      XK(7)=  292.5
      XK(8)=  300.9
      XK(9)=  310.7
      XK(10)=  320.4
      XK(11)=  331.5
      XK(12)=  342.5
      XK(13)=  354.3
      XK(14)=  367.9
      XK(15)=  381.5
      XK(16)=  397.4
      XK(17)=  413.3
      XK(18)=  430.5
      XK(19)=  450.9
      XK(20)=  471.4
      XK(21)=  496
      XK(22)=  521
      XK(23)=  548.6
      XK(24)=  582.1
      XK(25)=  616.9
      XK(26)=  659.5
      XK(27)=  704.5
      XK(28)=  756.1
      XK(29)=  821.2
      XK(30)=  892
     XK(31)=  984.1
     XK(32)=  1087.7
      XK(33)=  1215.5
     XK(34)=  1393.2
      XK(35)=1610.2
C
      YK(1)= 1.38900E+00
      YK(2)= 1.39300E+00
      YK(3)= 1.38700E+00
      YK(4)= 1.37200E+00
      YK(5)= 1.33100E+00
      YK(6)= 1.26400E+00
      YK(7)= 1.16100E+00
      YK(8)= 9.64000E-01
      YK(9)= 6.16000E-01
      YK(10)=3.92000E-01
      YK(11)=8.29000E-01
      YK(12)=1.14200E+00
      YK(13)=1.41900E+00
      YK(14)=1.65700E+00
      YK(15)=1.86400E+00
      YK(16)=2.07000E+00
      YK(17)=2.27500E+00
      YK(18)=2.46200E+00
      YK(19)=2.65700E+00
      YK(20)=2.86900E+00
      YK(21)=3.09300E+00
      YK(22)=3.32400E+00
      YK(23)=3.58600E+00
      YK(24)=3.85800E+00
      YK(25)=4.15200E+00
      YK(26)=4.48300E+00
      YK(27)=4.83800E+00
      YK(28)=5.24200E+00
      YK(29)=5.72700E+00
      YK(30)=6.31200E+00
      YK(31)=6.99200E+00
```

```
      YK(32)=7.79500E+00
      YK(33)=8.82800E+00
      YK(34)=1.01000E+01
      YK(35)=1.18500E+01
C
            MK(1)=  -0.0003008081
            MK(2)=  -0.0003008081
            MK(3)=  1.580026E-005
            MK(4)=  -0.0007139049
            MK(5)=  -0.0001736024
            MK(6)=  -0.0004512451
            MK(7)=  -0.001434666
            MK(8)=  -0.001597511
            MK(9)=  -0.0002189577
            MK(10)=  0.01017516
            MK(11)=  -0.004179221
            MK(12)=  0.0005716763
            MK(13)=  -0.0008454766
            MK(14)=  2.622849E-005
            MK(15)=  -0.0002650559
            MK(16)=  0.0001065387
            MK(17)=  -0.0001848276
            MK(18)=  -9.212307E-005
            MK(19)=  0.0001091794
            MK(20)=  -0.0001149184
            MK(21)=  2.897708E-005
            MK(22)=  3.033301E-005
            MK(23)=  -8.691511E-005
            MK(24)=  4.607977E-005
            MK(25)=  -4.050878E-005
            MK(26)=  1.402204E-005
            MK(27)=  -3.861147E-007
            MK(28)=  -1.769247E-005
            MK(29)=  2.877102E-005
            MK(30)=  -2.531625E-005
            MK(31)=  1.014666E-005
            MK(32)=  5.466382E-006
            MK(33)=  -1.243508E-005
            MK(34)=  7.599362E-006
            MK(35)=  7.599362E-006
c-------------------------------------------------
            if(xx.gt.600.) then
                  refre=0.0755 - 0.000155*xx + 2.15E-7*xx*xx
                  go to 29
            end if

C     Basic calculations
      J=2
10     IF (XX.LE.XN(J)) GO TO 20
      J=J+1
      GO TO 10
20     I=J
      XN0=XN(I)-XX
      XN1=XX-XN(I-1)
      H=XN(I)-XN(I-1)
      H2=H*H/6.0
      refre=MN(I-1)*XN0*XN0*XN0/6./H+MN(I)*XN1*XN1*XN1/6./H+
     +    (YN(I-1)-MN(I-1)*H2)*XN0/H+(YN(I)-MN(I)*H2)*XN1/H

29       J=2
30     IF (XX.LE.XK(J)) GO TO 40
      J=J+1
      GO TO 30
40     I=J
      XN0=XK(I)-XX
      XN1=XX-XK(I-1)
      H=XK(I)-XK(I-1)
      H2=H*H/6.0
      refim=MK(I-1)*XN0*XN0*XN0/6./H+MK(I)*XN1*XN1*XN1/6./H+
     +    (YK(I-1)-MK(I-1)*H2)*XN0/H+(YK(I)-MK(I)*H2)*XN1/H
c-----------------------------------------------------------------
```

```
c     Correction to the size limiting effect
c     Step1: calculation of the bulk parameter eps=eps1+ieps2
      eps1=refre*refre-refim*refim
      eps2=2.d0*refre*refim
C=======================================================================
c      Step 2: Calculation of coorection terms
c      WL=WAVEL
c      WLP=136.1D0
c      GB=0.0019D0
c      pi=4.d0*datan(1.d0)
c      GR=GB+0.0047*136.1/(2.0*pi*Rm)
c        deps1=(WL/WLP)**2*(1.D0/(1.D0+(GB*WL/WLP)**2)-
c     +       1.D0/(1.D0+(GR*WL/WLP)**2))
c        deps2=(WL/WLP)**2*((GR*WL/WLP)/(1.D0+(GR*WL/WLP)**2)-
c     +       (GB*WL/WLP)/(1.D0+(GB*WL/WLP)**2))

c

C        DEPS1=(OMPB/OM)**2*(1.D0/(1.D0+(GAMB/OM)**2)-
C     +       1.D0/(1.D0+(GAMJ/OM)**2))
C        DEPS2=(OMPB/OM)**2*((GAMJ/OM)/(1.D0+(GAMJ/OM)**2)-
C     +       (GAMB/OM)/(1.D0+(GAMB/OM)**2))

c     Step 2: Calculation of the coorection term
c     by using deps2 for IMAGINARY part of epsilon only!!!!
c          PARAMETERS:
c          hr=h/2/pi Reduced Plank constant=0.6582*10**(-15) eV*s
c          [hr]*omega_p=9 eV Average value for silver (vary from 9.5 to 8.7 eV
c          Lambda_p=138 nm (1240/9eV)
c          gamma_bulk~ 0.5-0.9 eV Here it is NOT USED
c          A=1 (Note that A=2-3 according to Quinten BOOK
c          v_F/c=0.0047 for Silver (Granquist)
c          hr*c/hr*omega_p=22 nm
c          deps2=(A/Rm)*(wavel/400)**3*(400/lambda_p)**3*(v_F/c)*(hr*c))/(hr*omega_p)
c          =2.5*(A/Rm)*(lambda/400)**3
c
      deps1=0.d0
            As=1.d0
            deps2=2.5d0*(As/Rm)*(wavel/400.d0)**3.d0

      eps1=eps1  + deps1
      eps2=eps2  + deps2
c-----------------------------------------------------------------------
c     Step 3: Recalculation of tefre and refim: Bohren-Huffman, p.281
      refre=dsqrt((dsqrt(eps1**2.d0+eps2**2.d0)+eps1)/2.d0)
      refim=dsqrt((dsqrt(eps1**2.d0+eps2**2.d0)-eps1)/2.d0)

            im=(0.d0,1.d0)
            eps=eps1+im*eps2
            ref=refre+im*refim
c-----------------------------------------------------------------------
      RETURN
      END
```

Section S4. Comparison of small-particle approximations with LM theory for the absorption cross section

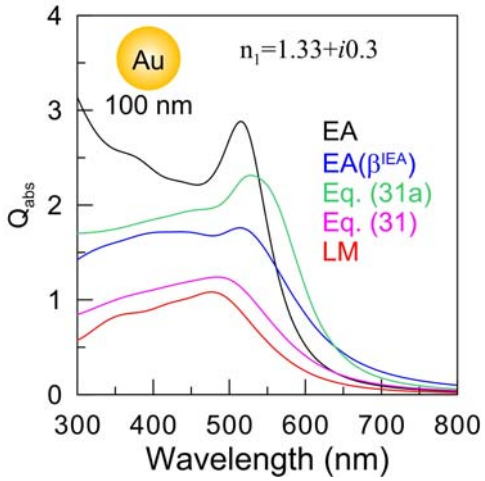

Figure S3. Absorption efficiency factors calculated by EA, EA with the IEA polarizability β^{IEA} (Eq. 30a), Eq. (31a), IEA (Eq. (31)), and LM theory for a 100-nm Au sphere in an absorbing host $n_1 = 1.33 + i0.3$.

Section S5. Comparison of the EA and LM near-field and far-field efficiencies for Au spheres embedded in a lossless PMMA and a lossy P3HT matrix

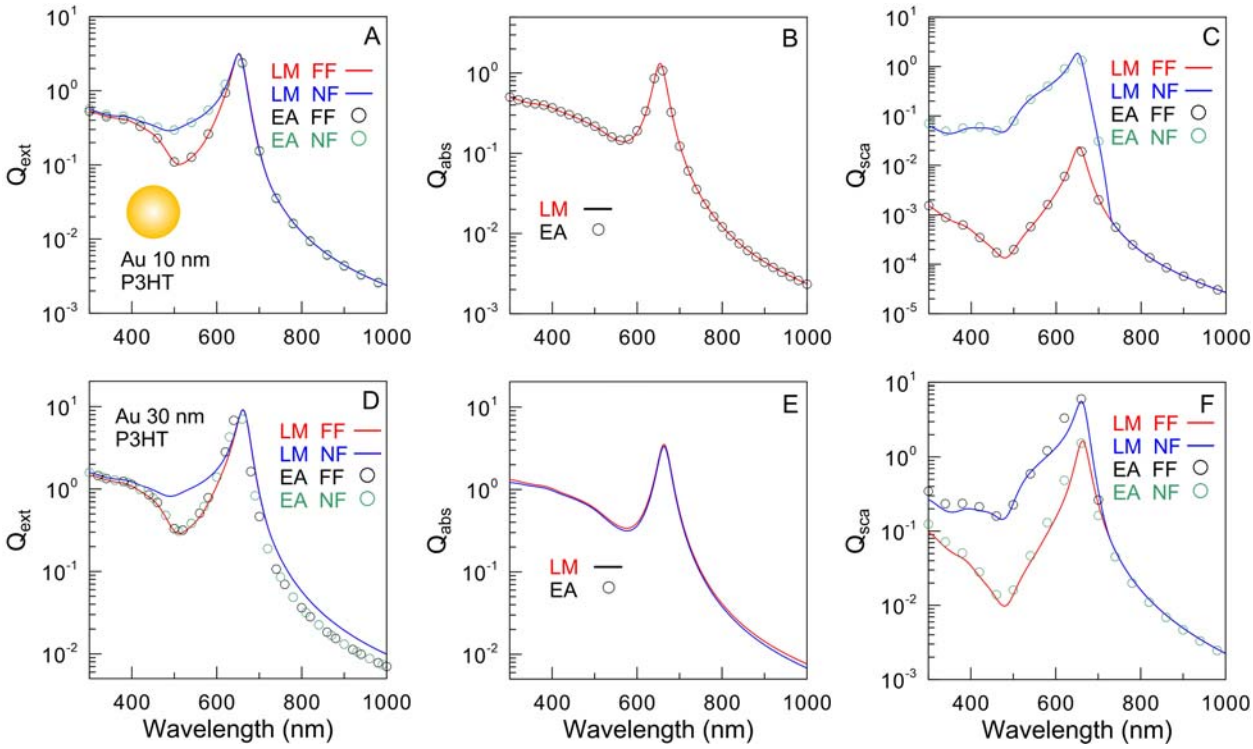

Figure S4. Far-field and near-field extinction (A, D), absorption (B, E), and scattering (C, F) efficiencies were calculated by the LM theory and the EA for 10-nm (A-C) and 30-nm Au spheres embedded in the P3HT matrix.

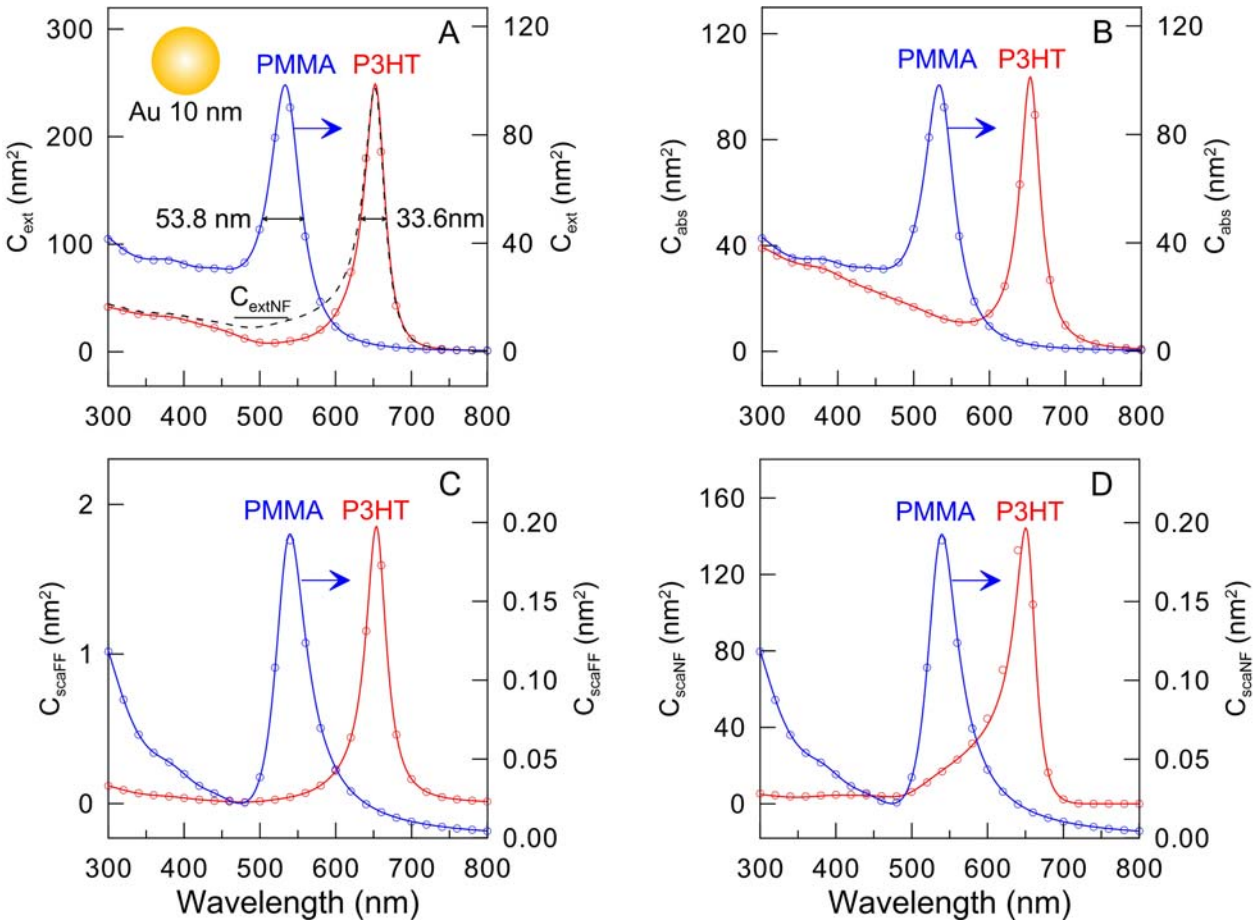

Figure S5. Cross sections from the LM theory (solid lines) and the EA approximation (circles). The extinction (A), absorption (B), near-field scattering (C), and far-field scattering (D) cross sections of a single 10-nm Au sphere embedded in a dielectric PMMA (blue lines) and a lossy P3HT (red lines) medium. The black dashed line in panel (A) shows the near-field extinction cross section. The black horizontal double arrows indicate the full width at half maximum of the extinction peaks.

Section S6. Comparison of LM, IEA, and FDTD FF extinction and scattering spectra for -10-nm Au sphere in lossy P3HT and dielectric water hosts.

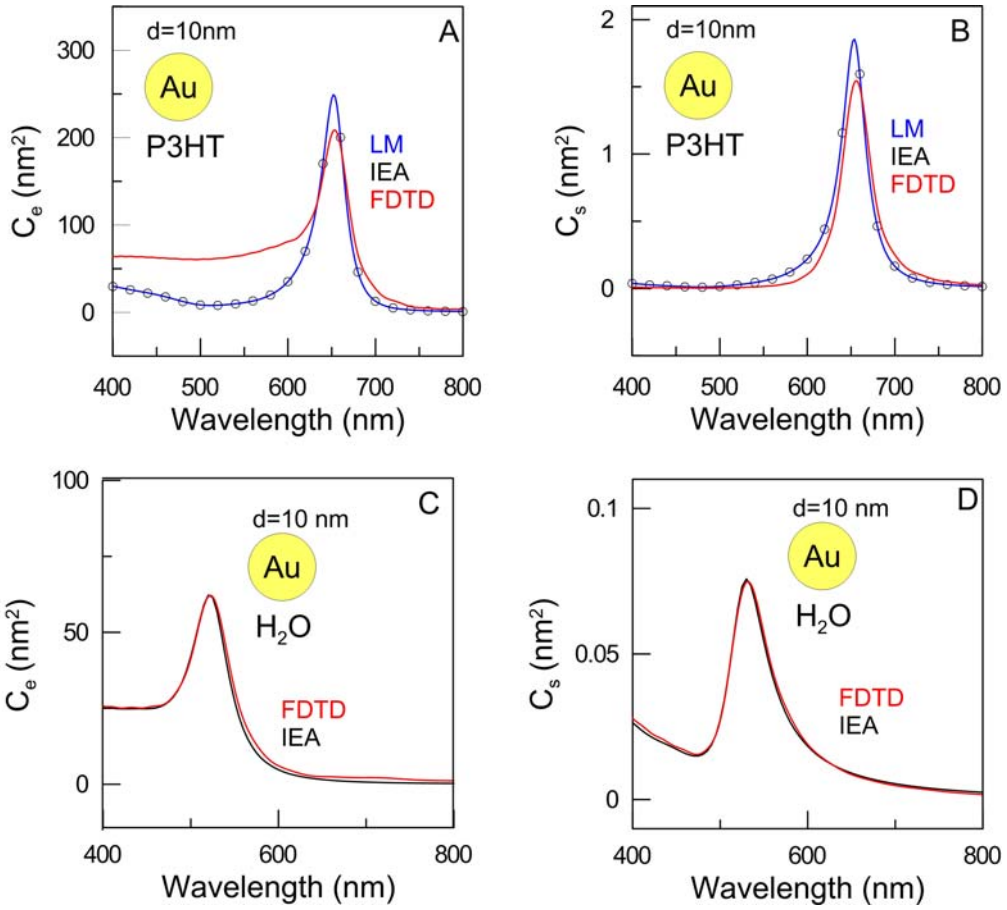

Figure S6. Extinction (A, C) and scattering (B, D) spectra of a 10-nm Au sphere in a lossy P3HT (A, B) and lossless water (C, D) hosts. Blue lines show LM simulations, black lines and circles show IEA simulations, and red lines show FDTD spectra. LM and IEA give perfect agreement for water hosts, and FDTD spectra are very close to IEA. However, for P3HT host, FDTD extinction spectrum is strongly overestimated in the short wavelength region. By contrast, LM and IEA spectra are in perfect agreement.

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