Supporting Information

Pt nanoparticles utilized as efficient ultraviolet plasmons for enhancing Whispering Gallery Mode lasing of a ZnO microwire via Ga-incorporation

Kunjie Ma, Xiangbo Zhou, Caixia Kan*, Juan Xu and Mingming Jiang*

College of Science, MIIT Key Laboratory of Aerospace Information Materials and Physics, Key Laboratory for Intelligent Nano Materials and Devices, Nanjing University of Aeronautics and Astronautics, No. 29 Jiangjun Road, Nanjing 211106, P. R. China.

*Corresponding Authors:

Prof. Mingming Jiang: mmjiang@nuaa.edu.cn

Prof. Caixia Kan: cxkan@@nuaa.edu.cn

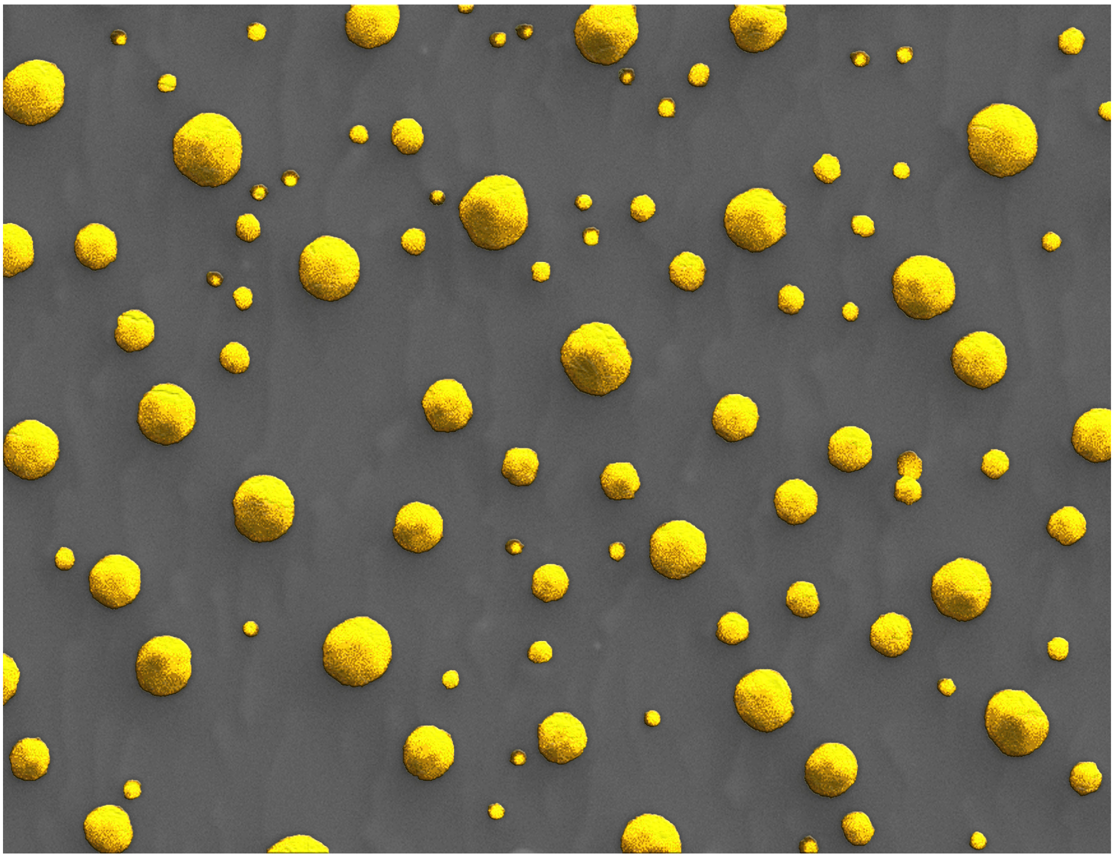

Figure S1. SEM image of PtNPs prepared on quartz substrate, with the average diameter of about 60 nm.

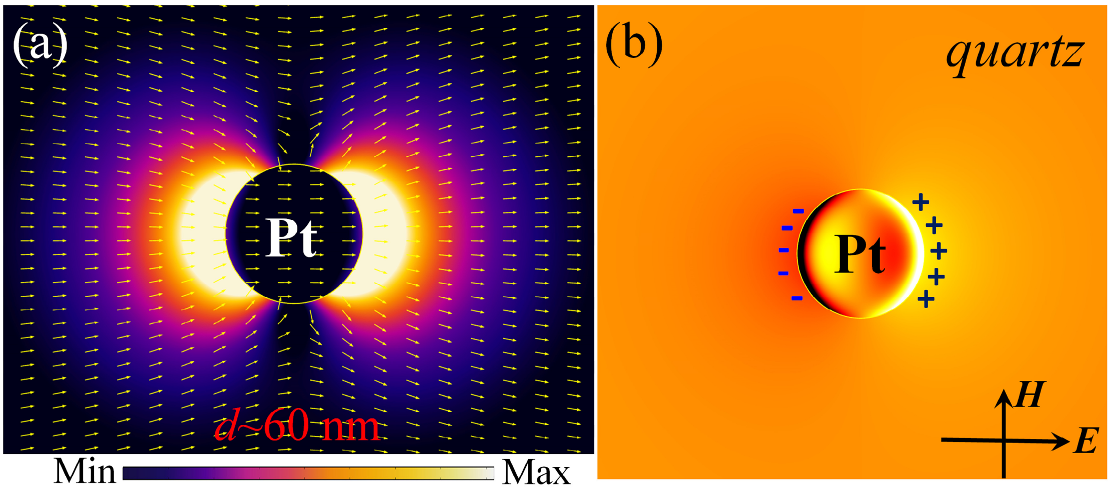

Figure S2. (a) Electric-field distribution of a PtNP (*d* ~ 60 nm), upon the ultraviolet excitation at a wavelength of 310 nm. (c) Simulated plasmon mapping of a particle (*d* ~ 60 nm), upon the ultraviolet excitation at a wavelength of 310 nm.

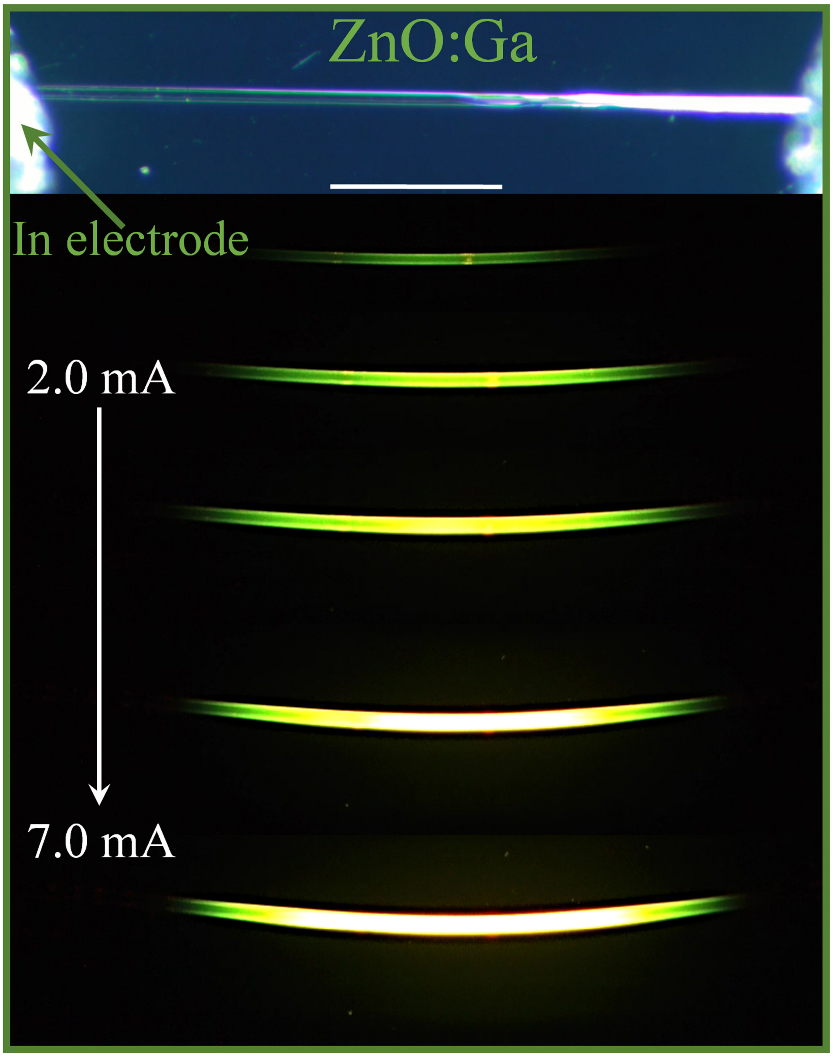

Figure S3. Bright and green light-emitting from electrically driven single bare ZnO:Ga MW based fluorescent emitter. The bright emission regions located towards the center of the wire (scale bar: 200 μm).

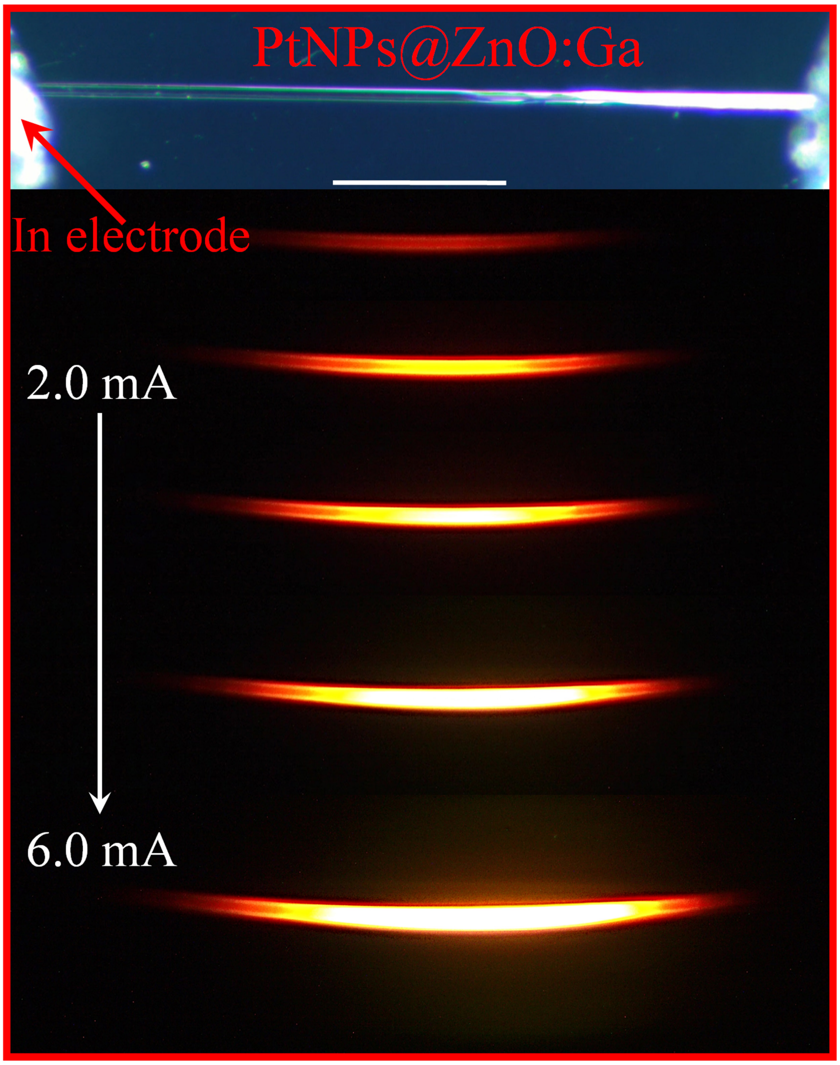

Figure S4. By incorporating Pt nanofilms, the corresponding green illuminating of the bare ZnO:Ga MW turned into red light-emitting from electrically-driven the single wire based fluorescent emitter. The bright emission regions located towards the center of the wire (scale bar: 200 μm).

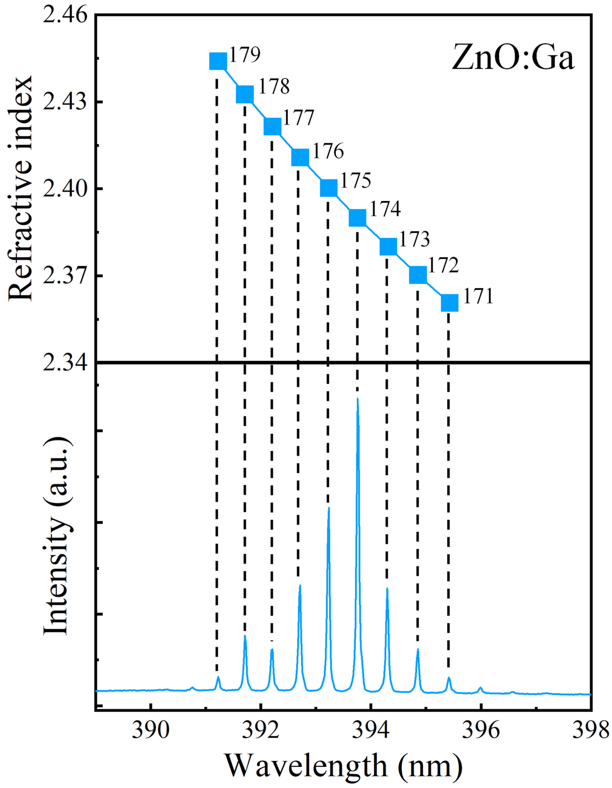

Figure S5. Relationship between the emission spectrum and refractive index of a single ZnO:Ga MW. Due to the WGM formula, the diameter of the MW was evaluated to be D = 11.2 μm, which is approximated to the experimentally observed value.

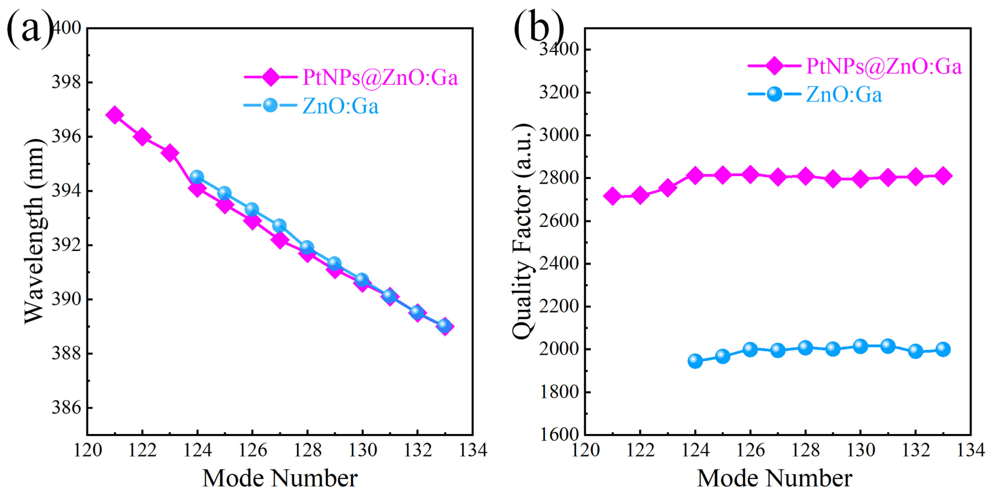

Figure S6. (a) Lasing wavelength dependent mode number of a ZnO:Ga MW prepared with, and without PtNPs deposition. (b) Q-factor dependent mode number of a ZnO:Ga MW decorated with and without PtNPs deposition.

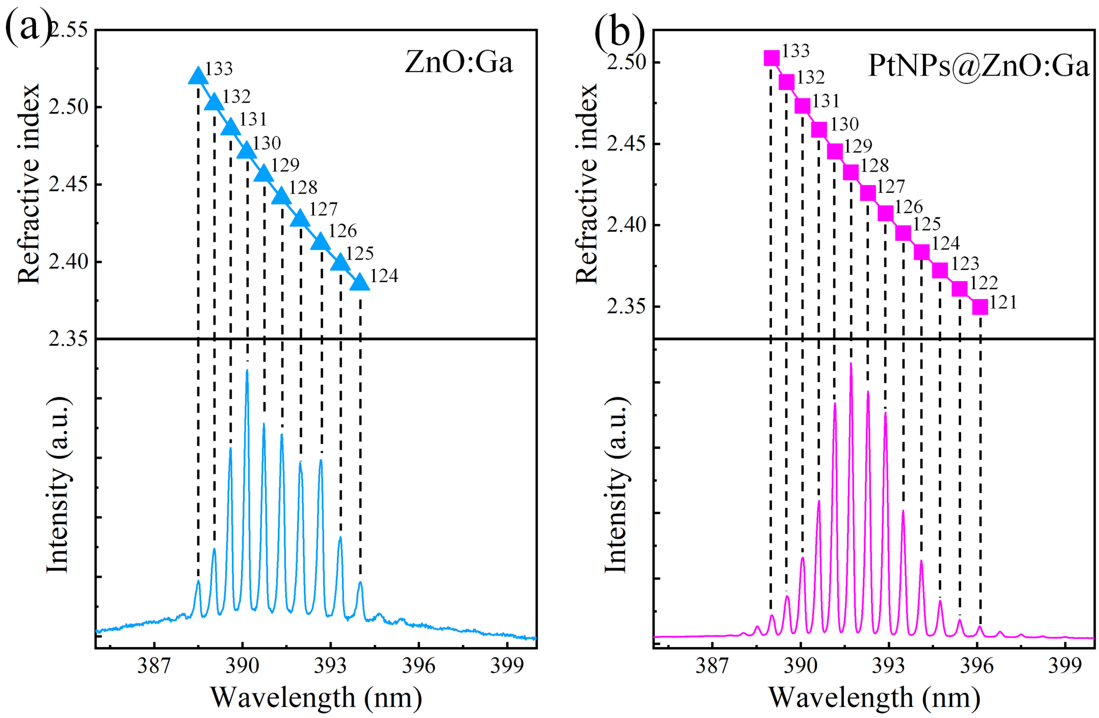

Figure S7. Relationship between the lasing emission spectrum and refractive index of a single ZnO:Ga MW (the diameter of the MW D = 9.0 μm) (a) not covered, and (b) covered by PtNPs, when operated at the same pumping power.

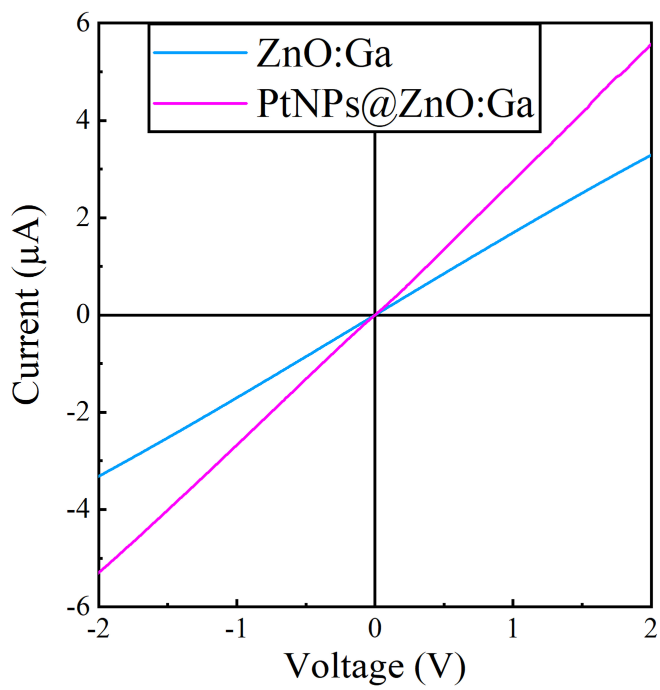

Figure S8. The dark current via *I-V* curves of single ZnO:Ga MW not decorated, and decorated by PtNPs.

Further to illustrate the numerical simulations of WGM microresonator and near-field electromagnetic responses of an individual PtNP via hemispheric structure placed on ZnO:Ga MW, a 3D model was constructed, as shown in Figure S9. The model is illuminated with a monochromatic plane wave, with the incident wave vector ***K*** contained either in the *x*-*z*-plane, or in the *y*-*z*-plane, with respect to the *z*-direction. Accordingly, the corresponding electric field (***E***) and magnetic field (***H***) are defined along the *x*-direction and *y*-direction respectively. This geometry was further illustrated in Figures S9(b) and S9(c) for a hemispheric PtNP placed on the ZnO:Ga.

For quantitative analysis, the extinction spectrum of an individual PtNP is calculated with the finite-difference time-domain (FDTD) method using a commercial software by Lumerical Inc. A normal incident total-field scattered-field source (TFSF) polarized along the *z*-axis and perfectly matched layer boundaries were used, and the models are illuminated at normal incidence. The simulated electric field distribution $|\boldsymbol{E}|^2$ of an individual PtNP placed on ZnO:Ga MW in the *x*-*y*-plane and *x*-*z*-plane, were also performed respectively. In the simulation, perfect matched layer (PML) is utilized to absorb the outgoing waves. Additionally, the complex relative permittivity ε of Pt at the excitation wavelength can be referred to Figure S10 [1-3].

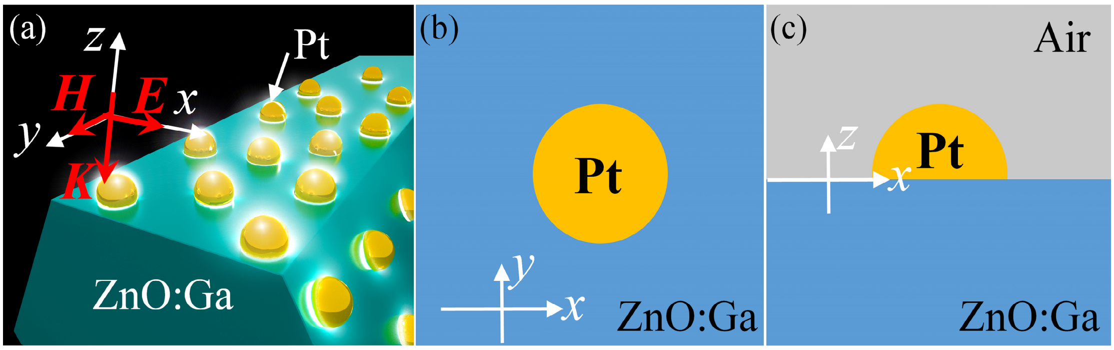

Figure S9. (a) 3D model of an individual hemispheric PtNP placed on the ZnO substrate. (b) Top view of the model in the *x*-*y*-plane. (c) The cross section along the Pt/ZnO:Ga interface in the *x*-*z* plane.

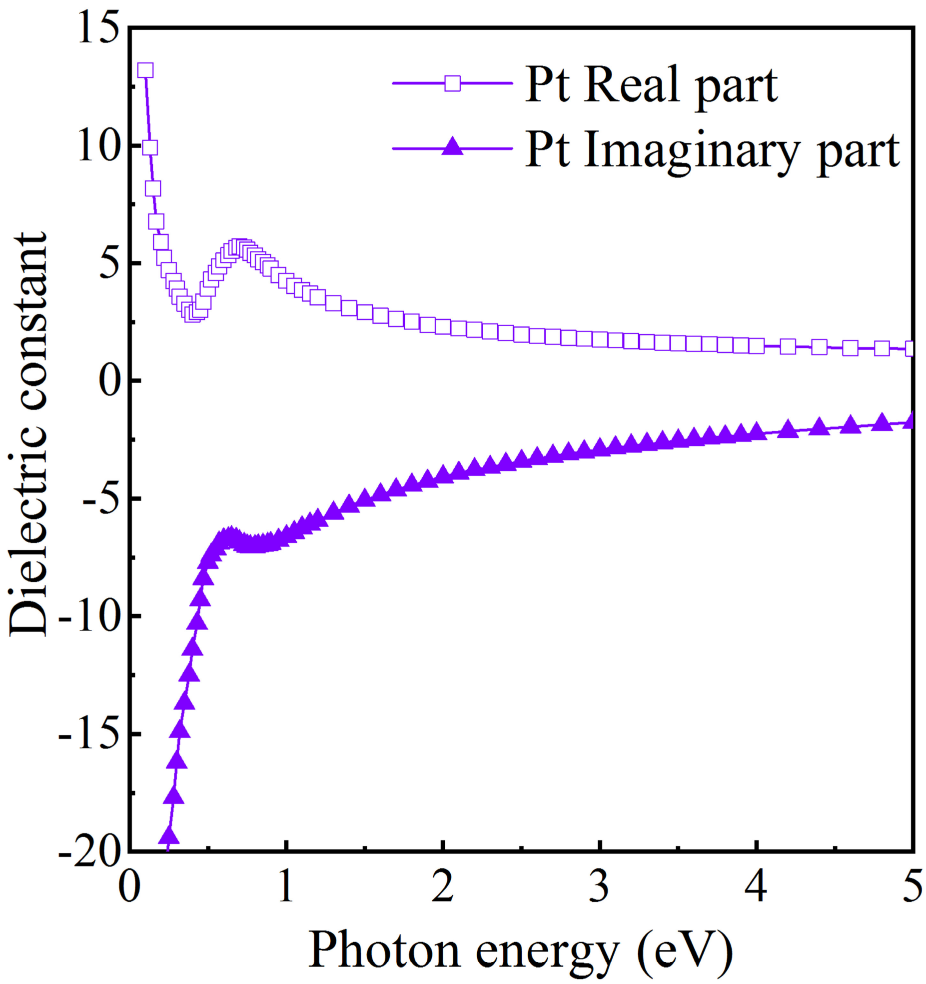

Figure S10. Dielectric function for Pt used in the calculations.

References:

1. J. H. Weaver, Phys. Rev. B 11, 1416 (1975).
2. Y.-C. Yu, W. E. Spicer, and G. Hass, Phys. Rev. 171, 834 (1968).
3. A. L. Henke, P. Lee, T. J. Tanaka, R. L. Shimabukuro, and B. K. Fujikawa, "Low Energy X-Ray Diagnostics--1981" (D. T. Attwood and B. L. Henke, eds.), p. 340, AlP Conf. Proc. No. 75, American Institute of Physics, New York, 1981.