

## **Zinc Porphyrin-Polydopamine Core-Shell Nanostructure for Enhanced Photodynamic/Photothermal Cancer Therapy**

Changjin Ou,<sup>a‡</sup> Yewei Zhang,<sup>d‡</sup> Dong Pan,<sup>c</sup> Kaikai Ding,<sup>a</sup> Shichao Zhang,<sup>a</sup> Wenjing Xu,<sup>d</sup>  
Wenjun Wang,<sup>b</sup> Weili Si,<sup>a\*</sup> Zhou Yang,<sup>c\*</sup> Xiaochen Dong<sup>a\*</sup>

<sup>a</sup>School of Physical and Mathematical Sciences, Key Laboratory of Flexible Electronics (KLOFE) & Institute of Advanced Materials (IAM), Nanjing Tech University (NanjingTech), Nanjing 211800, China. Email: *iamxcdong@njtech.edu.cn*, *iamwlsi@njtech.edu.cn*.

<sup>b</sup>School of Physical Science and Information Technology, Liaocheng University, Liaocheng 252059, China

<sup>c</sup>School of Materials Science and Engineering, University of Science and Technology Beijing, Beijing, China. *E-mail: yangz@ustb.edu.cn*

<sup>d</sup>Department of Hepatobiliary and Pancreatic Surgery, Zhongda Hospital, Medical School, Southeast University, Nanjing 210009, China.

<sup>‡</sup>These authors contributed equally

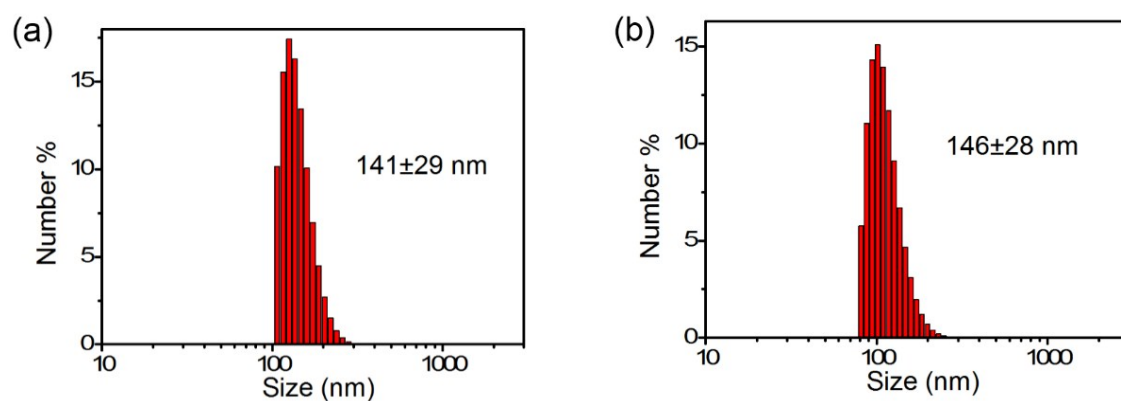


Figure S1. DLS distribution of ZnP@PDA NPs before (a) and (b) after storing for one week at room temperature.

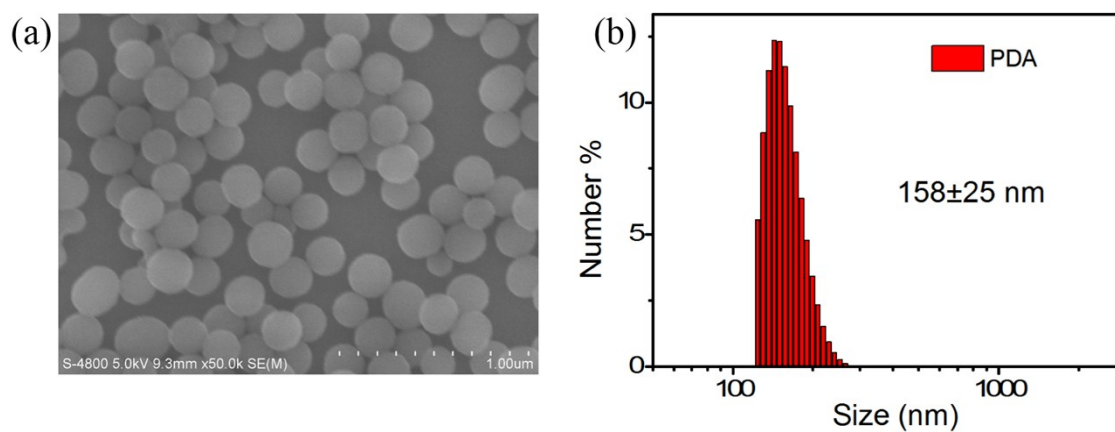


Figure S2. (a) SEM image and (b) DLS distribution of PDA nanoparticles.

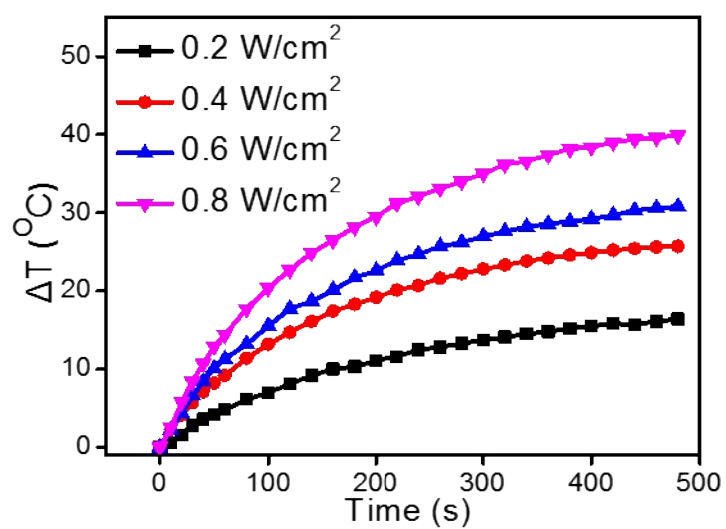


Figure S3. Photothermal effect of ZnP@PDA NPs (100 µg/mL) irradiated by different laser power density.

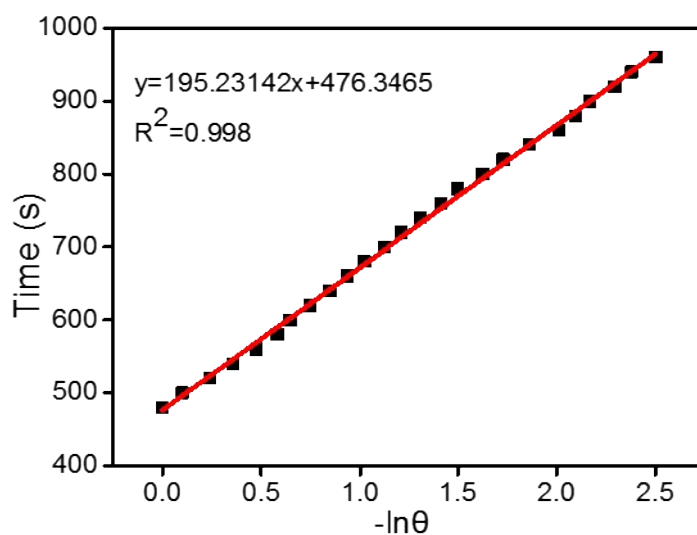


Figure S4. Linear fitting of ZnP@PDA NPs to calculate the photothermal conversion efficiency.

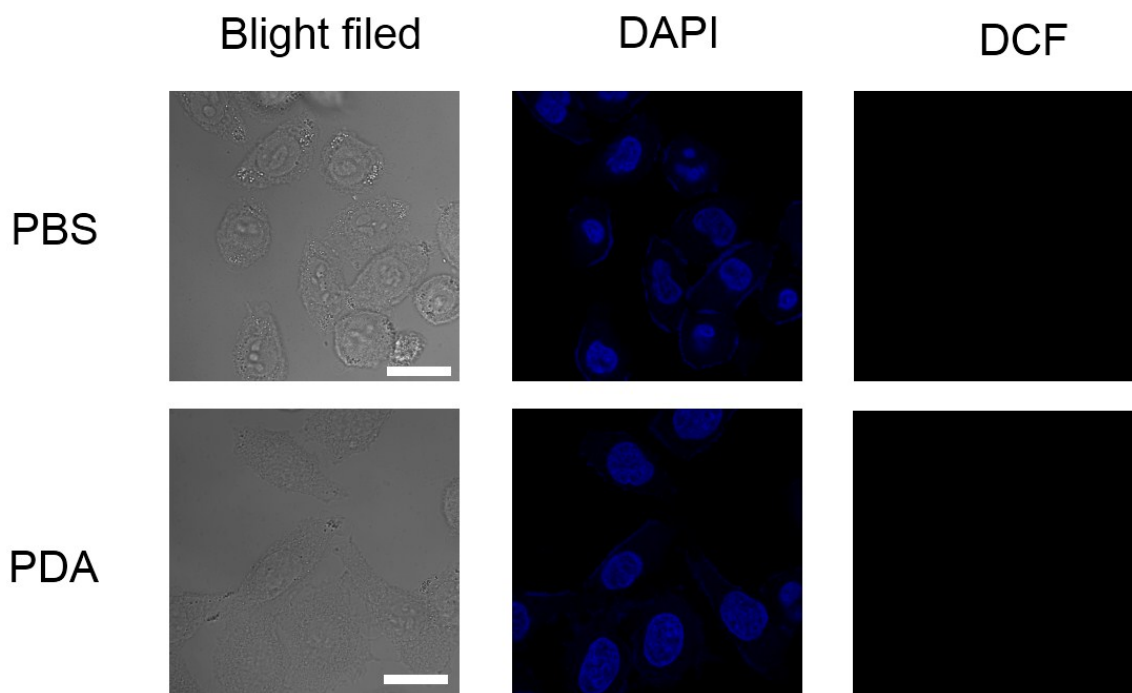


Figure S5. Confocal fluorescence images of HeLa cells incubated with PDA NPs (10  $\mu\text{g/mL}$ ) and PBS solution. Since PDA did not have  $^1\text{O}_2$  generation ability, the green fluorescence of ROS probe (DCFH-DA) could not be observed. Scale bar: 20  $\mu\text{m}$ .

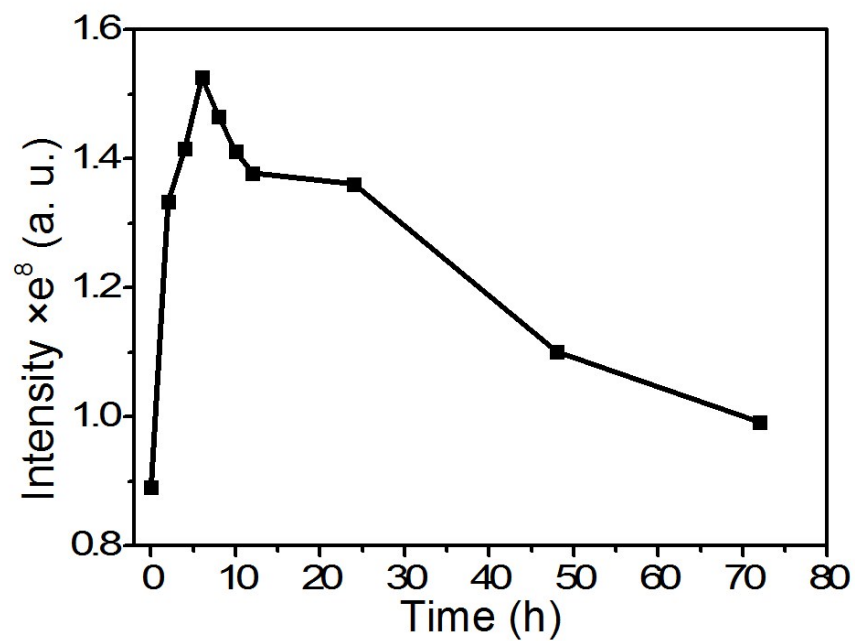


Figure S6. *In vivo* fluorescence intensity of tumor as a function of time.

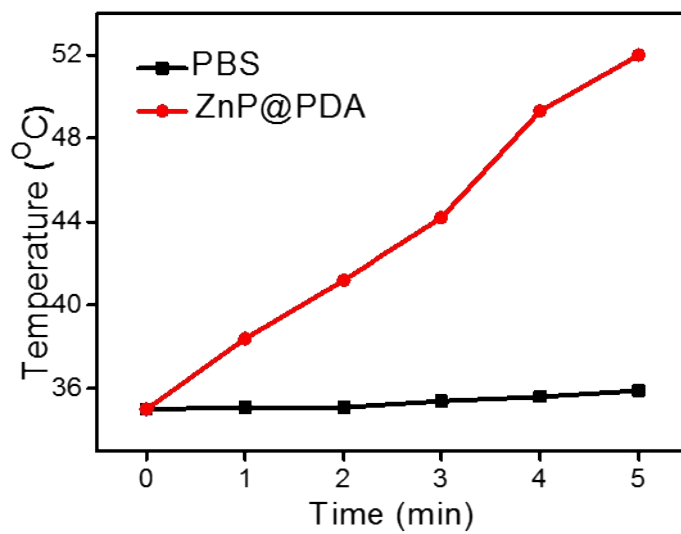


Figure S7. The highest temperature in tumor site when irradiation with 660 nm laser (0.75 W/cm<sup>2</sup>) for 5 minutes during the treatment.



Figure S8. Photographs of different groups of nude mice after treatment, the tumor in the treatment group almost disappeared.

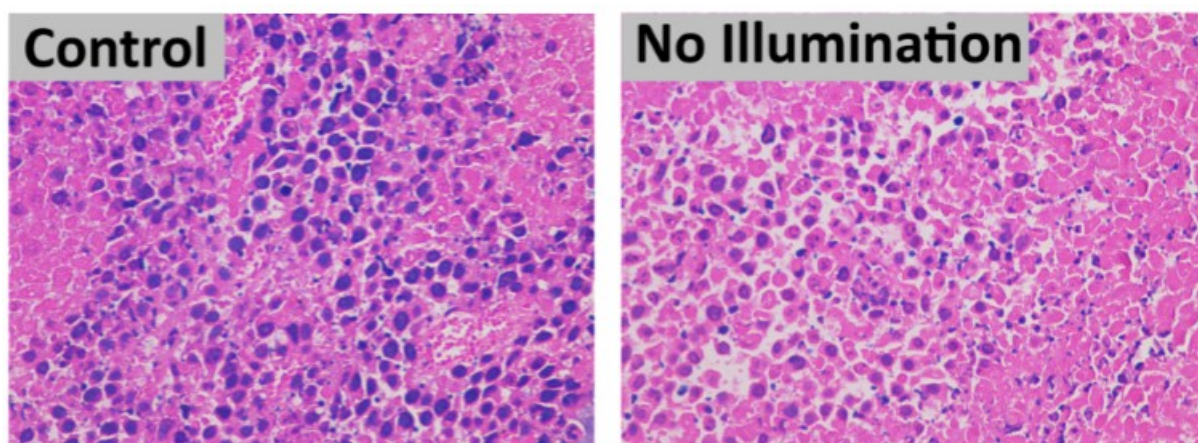


Figure S9. Tumor slice of control group and no illumination group.

Table S1. Photothermal conversion efficiency (PCE) of ZnP@PDA NPs and other

photothermal agents reported in the literatures.

Material	excitation wavelength (nm)	PCE (%)	Ref.
ZnP@PDA NPs	660	46.8	this work
spiky gold NPs	980	78.8	1
DPPCN-Fc	730	59.1	2
fusing isoindigo	808	57.9	3
SPN <sub>I-II</sub>	1064	43.4	4
HMPBS	808	41.4	5
PDA	808	40	6
IABDP	730	37.9	7
ZnP NPs	660	33.4	8
SPN1	808	30	9

#### Reference:

1. Bi C, Chen J, Chen Y, *et al.* Realizing a record photothermal conversion efficiency of spiky gold nanoparticles in the second near-infrared window by structure-based rational design. *Chem. Mater*, 2018, 30, 2708-2719.
2. Liang P, Tang Q, Cai Y, *et al.* Self-quenched ferrocenyl diketopyrrolopyrrole organic nanoparticles with amplifying photothermal effect for cancer therapy. 2017, 8, 7457-7463.
3. Jiang Y, Zhang X, Deng Y, *et al.* Fused isoindigo ribbons with absorption bands reaching near-infrared. *Angew. Chem. Int. Ed*, 2018, 57, 10283-10287.
4. Jiang Y, Li J, Zhen X, *et al.* Dual-peak absorbing semiconducting copolymer nanoparticles for first and second near-infrared window photothermal therapy: A comparative study. *Adv. Mater*, 2018, 30, 1705980.



5. Cai X, Jia X, Gao W, et al. A versatile nanotheranostic agent for efficient dual-mode imaging guided synergistic chemo-thermal tumor therapy. *Adv. Funct. Mater.*, 2015, 25, 2520-2529
6. Liu Y, Ai K, Liu J, et al. Dopamine-melanin colloidal nanospheres: An efficient near-infrared photothermal Ttherapeutic agent for in vivo cancer therapy. *Adv. Mater.*, 2013, 25, 1353-1359.
7. Tang Q, Si W, Huang C, et al. An aza-BODIPY photosensitizer for photoacoustic and photothermal imaging guided dual modal cancer phototherapy. *J. Mater. Chem. B*, 2017, 5, 1566-1573.
8. Ding K, Zhang, Y, Si W, et al. Zinc(II) metalated porphyrins as photothermogenic photosensitizers for cancer photodynamic/photothermal synergistic therapy. *ACS Appl. Mater. Interfaces*, 2018, 10, 238-247.
9. Lyu Y, Xie C, Chechetka S, et al. Semiconducting polymer nanobioconjugates for targeted photothermal activation of neurons. *J. Am. Chem. Soc.* 2016, 138, 9049-9052.