Electronic Supplementary Information

The Effects of Food on the Uptake and Excretion of Nano-plastics by *Daphnia magna*

Xiao-Jing Liu, Yu-Hang Zhang, Rong-Yao Gao, Hua-Bing Jia, Qian-Qian Shao, Ya-Wen Hu, Li-Min Fu * and Jian-Ping Zhang *

Key Laboratory of Advanced Light Conversion Materials and Biophotonics, Department of Chemistry, Renmin University of China, Beijing 100872, China.

Corresponding Authors
Tel: +86-10-62516604; e-mail: lmfu@ruc.edu.cn (L.-M.F.).
Tel: +86-10-62516604; e-mail: jpzhang@ruc.edu.cn (J.-P.Z.)

ORCID
Li-Min Fu: 0000-0002-5544-9548

***Materials*:** $LuCl_3\ 6H_2O$ (99.99%), $YbCl_3\ 6H_2O$ (99.99%), $ErCl_3\ 6H_2O$ (99.99%) were obtained from Beijing Innochem Science & Technology company. NH_4F (98%) and NaOH (98.5%) were obtained from J&K Chemical. Oleic acid (OA, >90%), octadecane (ODE, >90%) and styrene (St) were supplied by Alfa Aesar. Ammonia solution were supplied by Shanghai Aladdin Biochemical Technology Co.,Ltd. IGEPAL. CO-520 was purchased from Sigma-Aldrich, Ethyl silicate (TEOS) was purchased from Sinopharm Chemical Reagent Co.Ltd. 3-Methacryloxypropyltrimethoxysilane (MPS) was purchased Anhui Senrise Technologies Co., Ltd., Acrylic acid (AA, 99.5%) was purchased from J&K Scientific, Divinylbenzene (DVB, 80%) was purchased from Anhui Zesheng Technology Co., Ltd. Cyclohexan and Potassium Persulfate (KPS) were purchased from Beijing Chemical Plants.

***Synthesis of $NaLuF_4$: 20% Yb, 2% Er*:** 0.78 mmol of $LuCl_3\ 6H_2O$, 0.2 mmol of $YbCl_3\ 6H_2O$ and 0.02 mmol of $ErCl_3\ 6H_2O$ were dissolved in 15 mL of ODE and 6 mL of OA. The mixture was stirred for 10 min and was heated to 135 ℃, the air and water was removed by vacuum and argon. When the temperature naturally cooled down to 80 ℃, 4 mmol NH_4F and 2.5 mmol NaOH were added to the three-neck flask. The mixture was heated to within 15 min and maintained 295 ℃ under strong argon atmosphere for 1.5 h. Then the $NaLuF_4$: 20% Yb, 2% Er were collected by centrifugation at the speed of 10000 rpm for 2 min. It was repeatedly washed with ethanol and cyclohexane and finally dispersed in cyclohexane.

***Synthesis of $NaLuF_4$: 20% Yb, 2% Er@$NaLuF_4$*:** 1 mmol of $LuCl_3\ 6H_2O$ was dissolved in 15 mL of ODE and 6 mL of OA, stirred for 10 min. The next step is same as the synthesis of $NaLuF_4$: 20% Yb, 2% Er, but the $NaLuF_4$: 20% Yb, 2% Er needs to be added uniformly to form a homogenous solution. The temperature naturally cooled down to 80 ℃. The mixture finally was dispersed in 12 mL cyclohexane.

***Synthesis of $NaLuF_4$: 20%Yb, 2%Er@$NaLuF_4$@SiO_2*:** The 5 mL of cyclohexane containing 1.0 g CO-520 and 5 mL of cyclohexane solution containing 0.1 mmol $NaLuF_4$: 20% Yb, 2% Er@$NaLuF_4$ were fully mixed. 80 μL $NH_3\cdot H_2O$ was added in continuous stirring for 3 h, then 40 μL TEOS was added to the mixture. After 24 h, 20 μL MPS was added and stirred for 24 h. Finally, 10 mL ethanol was added to demulsificate. The product was collected by centrifugation, and then was washed several times and dispersed in 10 mL of ethanol.

***Synthesis of $NaLuF_4$: 20% Yb, 2% Er@$NaLuF_4$@SiO_2@PS*:** The $NaLuF_4$: 20% Yb, 2% Er@$NaLuF_4$@SiO_2 containing 10 mL of ethanol was added to a 100 mL three-neck flask containing 15 mL of ethanol and 25 mL of water. 0.3 mL St was added in the mixture and reacted for 0.5 h under argon atmosphere to remove oxygen. Then the mixture was heated to 75 ℃ and 1 mL of KPS was added to initiate polymerization. After 1 h, 0.2 mL St and 1 mL ethanol solution containing 20% AA and 8% DVB were added, and the reaction lasted for 3 h. The product was obtained by centrifugation, was washed several times and dispersed in 20 mL of water.

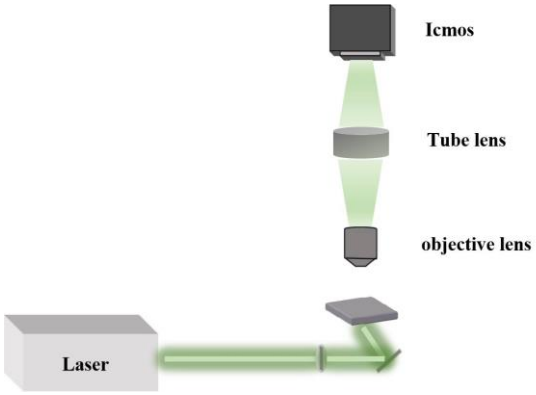

Figure S1. Schematic diagram of TGI system.

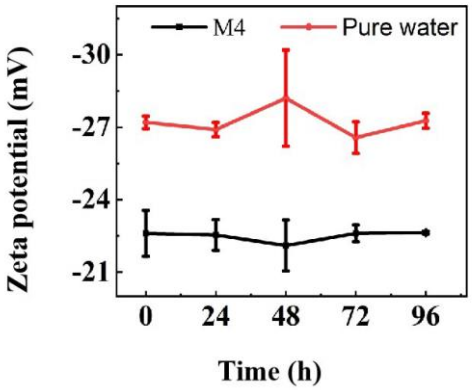

Figure S2. Zeta potential of UCNPs@PS with 100 mg/L in pure water and Elendt M4 medium was measured by nano zetasizer ZS90.

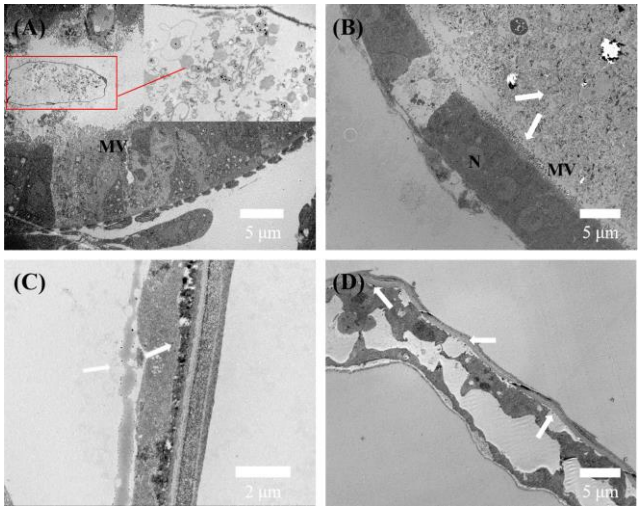

Figure S3. Different tissues of TEM images of the *D. magna* when exposed to NPs (3 mg/L) for 24 h. (A,B) Intestine tract; (C,D) carapace. Microvilli (MV), Nucleus (N), white arrows refers to NPs.

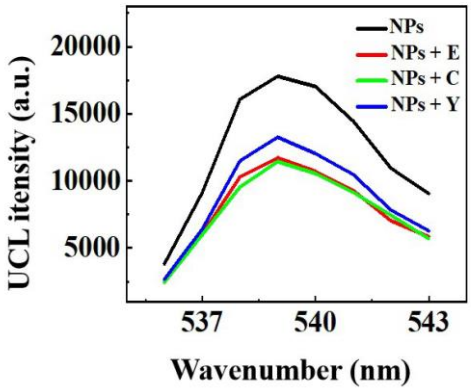

Figure S4. Sedimentation of NPs under different conditions was measured by FLS980. The foods were *Chlorella* sp. (C), *E. gracilis* (E), and yeast powder (Y).

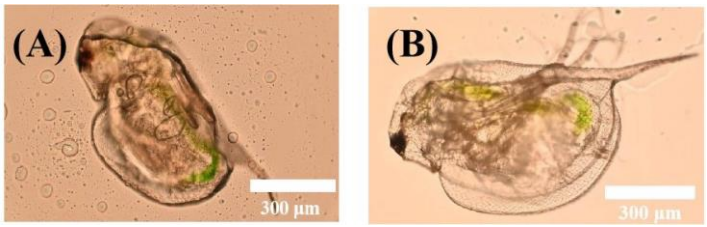

Figure S5. Food was ingested by *D. magna* in uptake of NPs experiments.

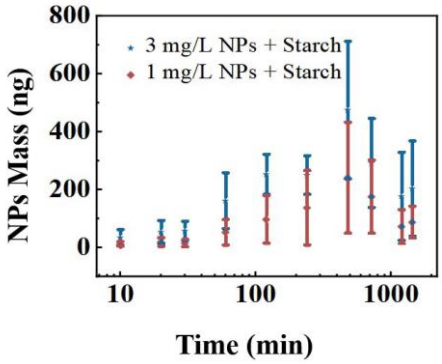

Figure S6. *D. magna* ingested NPs when the food was starch during the 24 h.

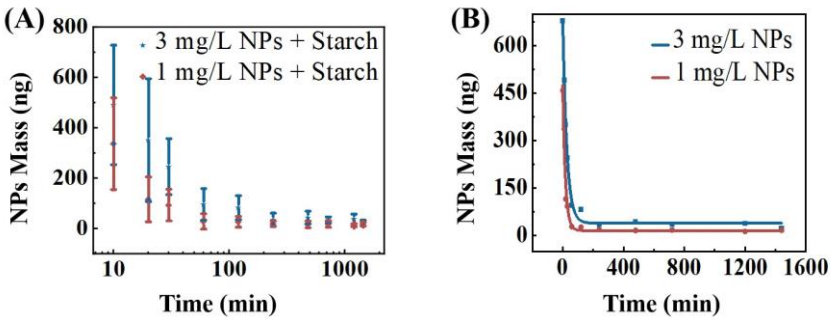

Figure S7: (A) *D. magna* excreting NPs when the food was starch during the 24 h; (B) single exponential fitting for *D. magna* excreting NPs.

The HUT medium, SE medium, and Elendt M4 medium [1] were used to cultivate the species.

Table S1. Chemical compositions of HUT medium for the cultivation of *E. gracilis*.

Chemical	Concentration (μg/L)
KH_2PO_4	20000
Peptone	600000
$MgSO_4 \cdot 7H_2O$	25000
yeast extract	400000
CH_3COONa	400000
Cyanocobalamine (B12)	0.5
$C_6H_5K_3O_7$	40000
Thiamine hydrochloride	400

Table S2. Chemical compositions of SE medium for the cultivation of *Chlorella* sp..

Chemical	Concentration (g/L)
$NaNO_3$	0.25
K_2HPO_4	0.075
$MgSO_4 \cdot 7H_2O$	0.075
$CaCl_2 \cdot 2H_2O$	0.025
KH_2PO_4	0.175
NaCl	0.025
$FeCl_3 \cdot 6H_2O$	0.005
EDTA-Fe	1 mL
A5 (Trace mental solution)	1 mL
soil extracting solution	40 mL

A5 (Trace mental solution)

Chemical	Concentration (g/L)
H_3BO_3	2.86
$MnCl_2 \cdot 4H_2O$	1.86
$ZnSO_4 \cdot 7H_2O$	0.22
$Na_2MoO_4 \cdot 2H_2O$	0.39
$CuSO_4 \cdot 5H_2O$	0.08
$Co(NO_3)_2 \cdot 6H_2O$	0.05

Table S3. Chemical compositions of Elendt M4 medium for the cultivation of *D. magna.*

Chemical	Concentration (μg/L)
H_3BO_3	2859.5
$MnCl_2 \cdot 4H_2O$	360.5
LiCl	306
RbCl	71
$SrCl_2 \cdot 6H_2O$	152
NaBr	16
$Na_2MoO_4 \cdot 2H_2O$	61.5
$CuCl_2 \cdot 2H_2O$	16.75

$ZnCl_2$	13
$CoCl_2 \cdot 6H_2O$	10
KI	3.25
Na_2SeO_3	2.19
NH_4VO_3	0.575
$Na_2EDTA \cdot 2H_2O$	2500
$FeSO_4 \cdot 7H_2O$	995.5
$CaCl_2 \cdot 2H_2O$	293800
$MgSO_4 \cdot 7H_2O$	123300
KCl	5800
$NaHCO_3$	64800
$Na_2SiO_3 \cdot 9H_2O$	10000
$NaNO_3$	274
K_2HPO_4	184
KH_2PO_4	143
Thiamine hydrochloride	75
Cyanocobalamine (B_{12})	1
Biotine	0.75

Reference

[1] OECD. *Test No. 211: Daphnia magna Reproduction Test;* OECD: Paris, France, 2012.