Supplementary Information

Bi$_2$Se$_3$ Nanoplates for Contrast-enhanced Photoacoustic Imaging at 1064 nm

Sara Park,[§a] Gyeongbae Park,[§b] Jeesu Kim,[a] Wonseok Choi,[a] Unyong Jeong,[*b] and Chulhong Kim[*b]

[a]Departments of Creative IT Engineering and Electrical Engineering, Pohang University of Science and Technology (POSTECH), 77 Cheongam-Ro, Nam-Gu, Pohang, Gyeongbuk, 37673, Republic of Korea.

[b]Department of Materials Science and Engineering, Pohang University of Science and Technology (POSTECH), 77 Cheongam-Ro, Nam-Gu, Pohang, Gyeongbuk, 37673, Republic of Korea.

[*]Corresponding author: chulhong@postech.edu and ujeong@postech.ac.kr

[§]These authors contributed equally to this work.

E-mail address:

Sara Park: sarapark@postech.ac.kr

Gyeongbae Park: rochellesalt@postech.ac.kr

Jeesu Kim: hybridjs@postech.ac.kr

Wonseok Choi: zoids1215@postech.ac.kr

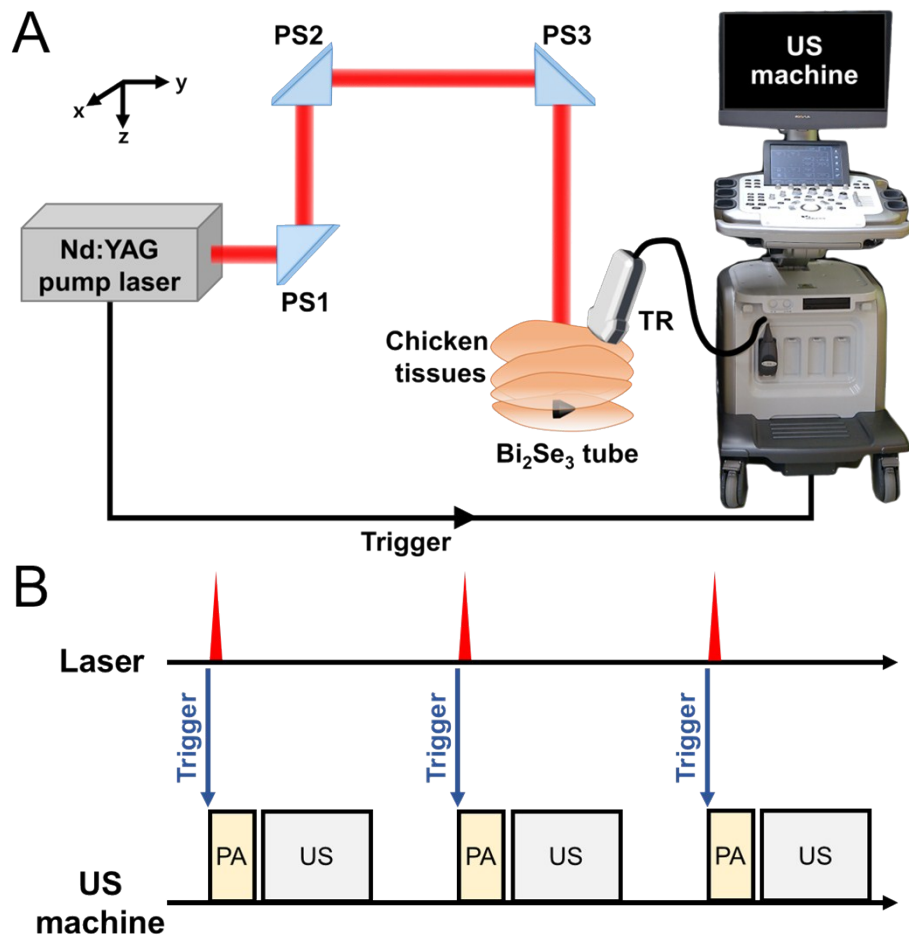Unyong Jeong: ujeong@postech.ac.kr

Chulhong Kim: chulhong@postech.edu

Fig. S1 Schematic of deep tissue PA imaging. (A) Experimental setup. (B) Synchronized timing sequence. PA, photoacoustic; PS, prism; US, ultrasound; TR, ultrasound transducer.
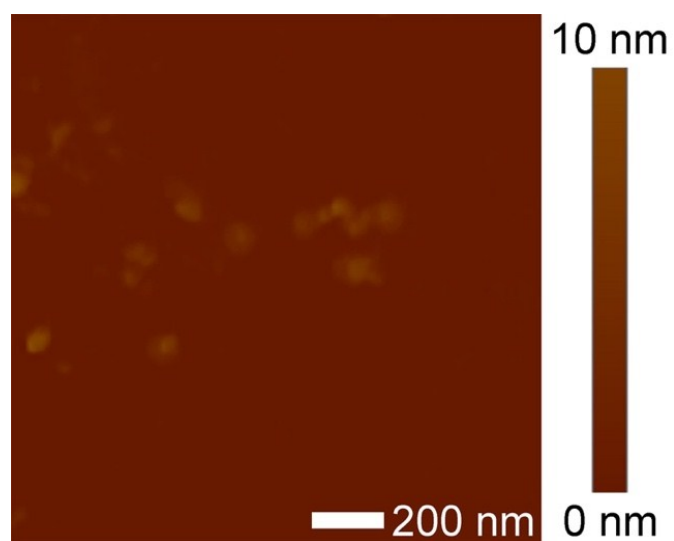
Fig. S2 AFM image of Bi$_2$Se$_3$ nanoplates spin-coated on the Si substrate. AFM, atomic force microscope.
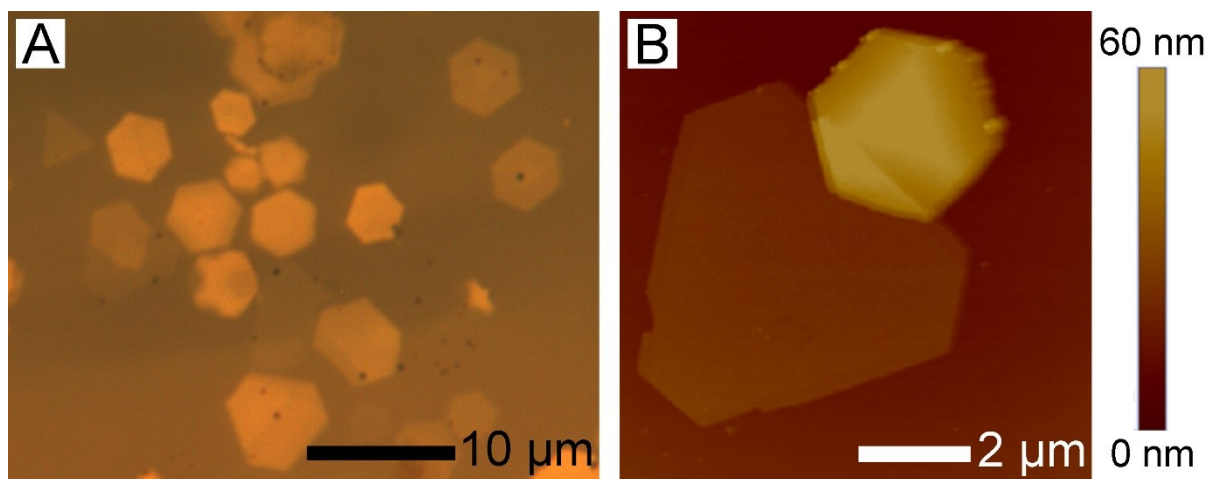
Fig. S3 Characterization of Bi_2Se_3 microplates on the Si substrate. (A) OM image and (B) AFM height image of Bi_2Se_3 microplates. OM, optical microscope; AFM, atomic force microscope.
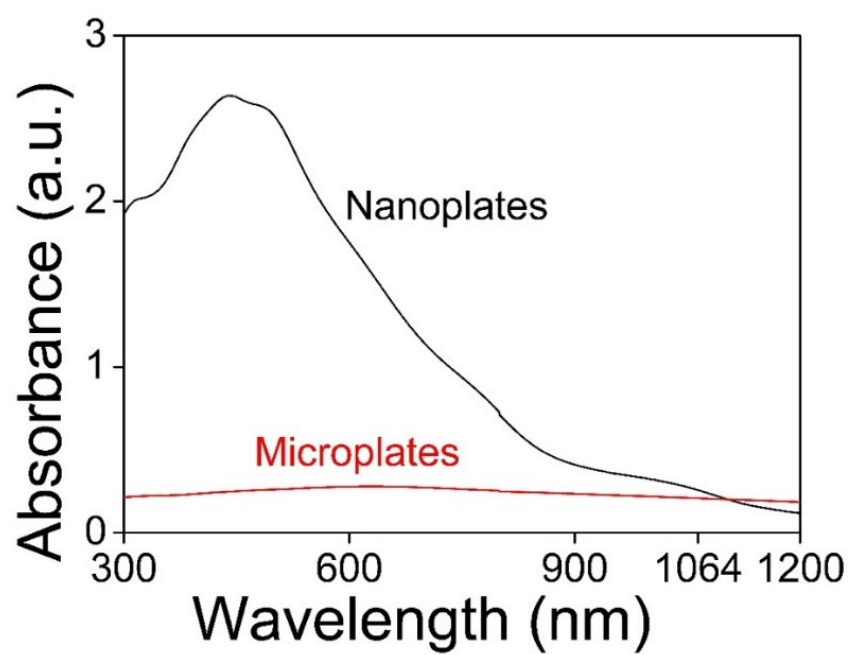
Fig. S4 Absorption spectra of Bi_2Se_3 nanoplates (black) and microplates (red).
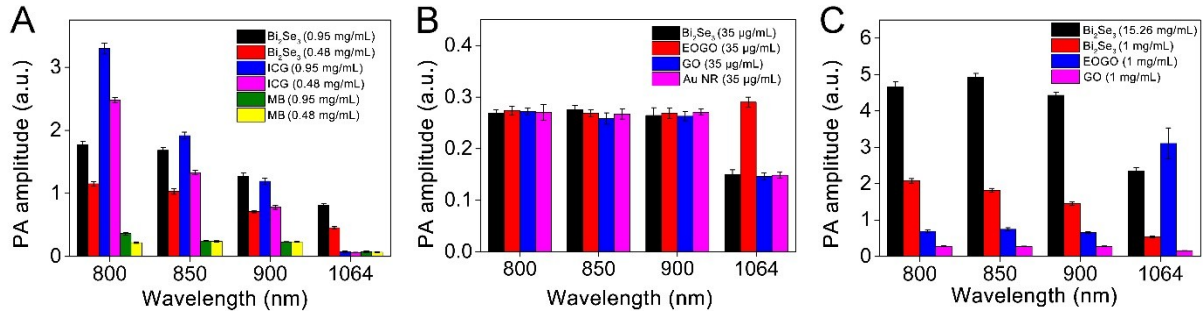
Fig. S5 *In vitro* PA characteristics of various dyes in NIR region. (A) PA spectral response of Bi_2Se_3 nanoplates, ICG, and MB (concentration: 0.95 mg/mL and 0.48 mg/mL). (B) PA spectral response of Bi_2Se_3 nanoplates, EOGO, and GO (concentration: 35 µg/mL). (C) PA spectral response of Bi_2Se_3 nanoplates, EOGO, GO, and Au NR (concentration: 1 mg/mL). The error bars represent +/- 1 standard deviation. PA, photoacoustic; NIR, near infrared; ICG, indocyanine green; MB, methylene blue; EOGO, edge-oxidized graphene oxide; GO, graphene oxide; Au NR, gold nanorod.
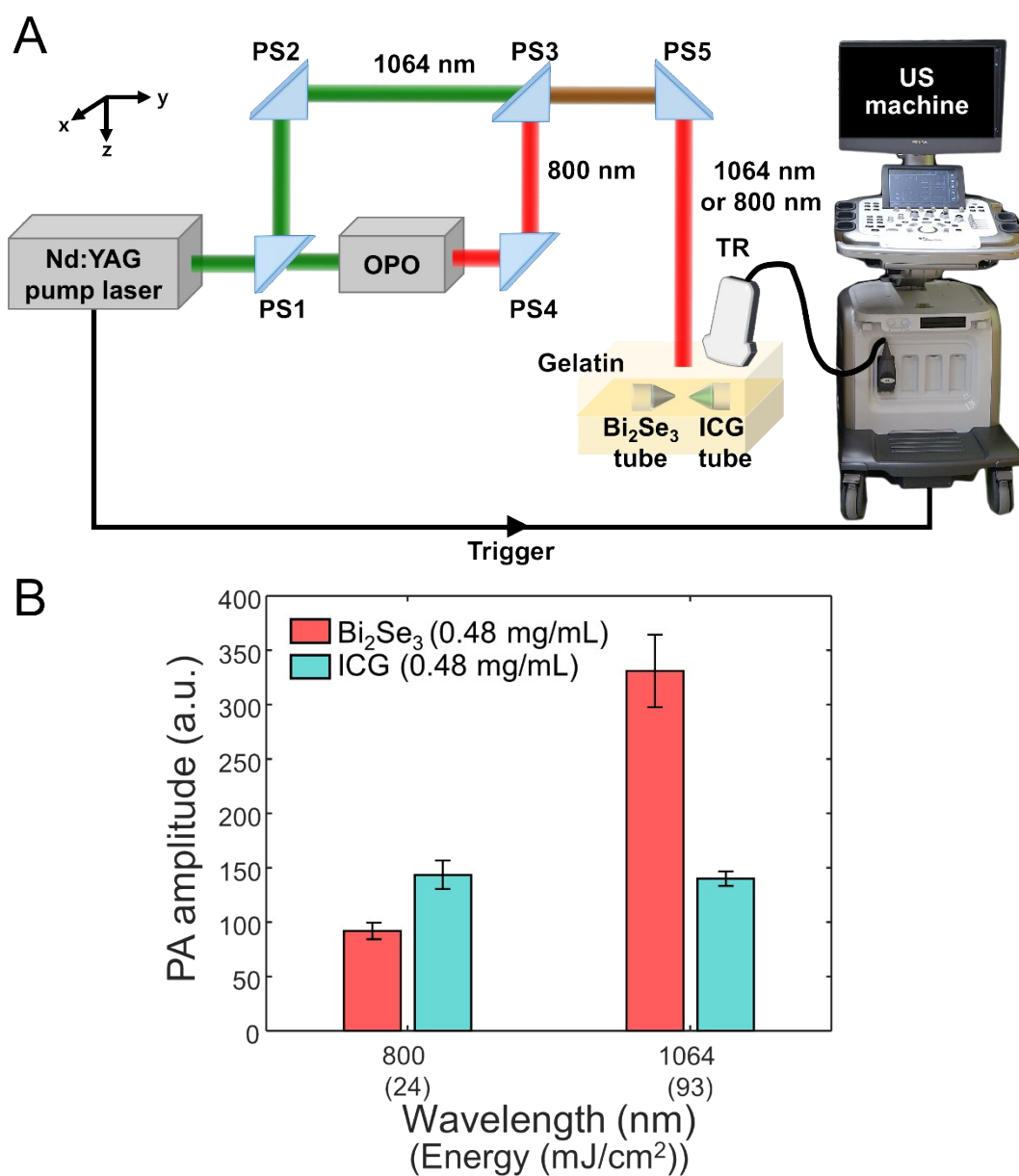
Fig. S6 *In vitro* PA characteristics of Bi_2Se_3 nanoplates and ICG at 800 nm and 1064 nm. (A)

Experimental setup. (B) Quantified PA amplitude of the Bi_2Se_3 nanoplates and ICG at 800 nm

and 1064 nm. The error bars represent +/- 1 standard deviation. PA, photoacoustic; OPO,

optical parametric oscillator; PS, prism; US, ultrasound; TR, ultrasound transducer; ICG,

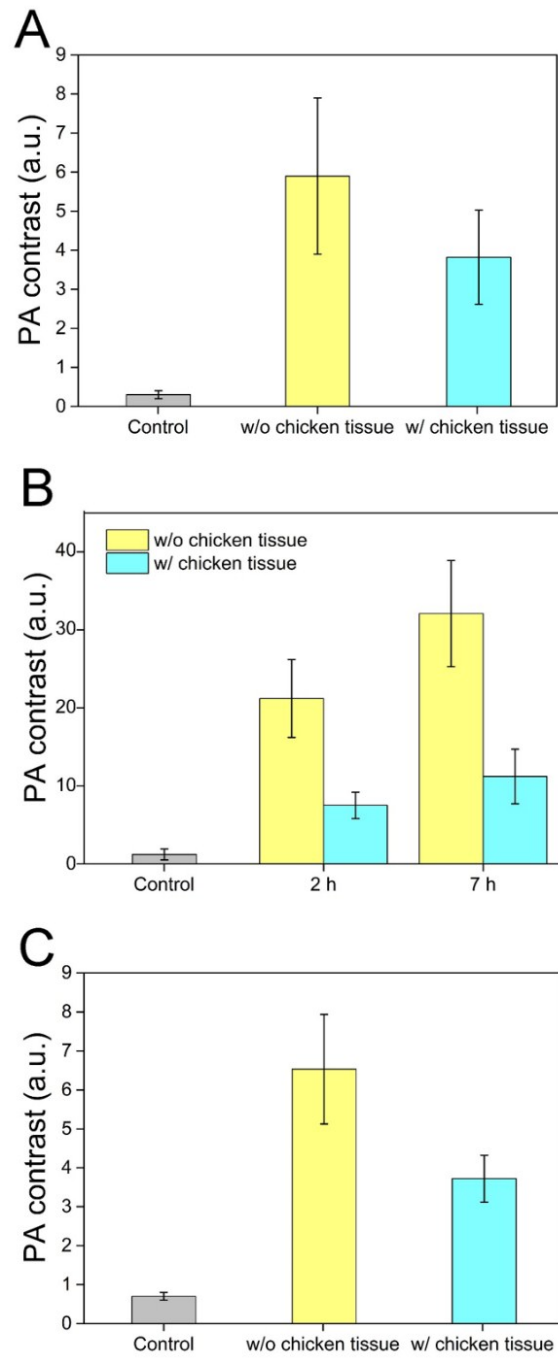indocyanine   green.

Fig. S7 PA contrast quantification in all *in vivo* imaging. (A) PA contrast between the bladder area and the background. (B) PA contrast between the GI area and the background after 2 hours and 7 hours. (C) PA contrast between the SLNs and the background. The error bars represent +/- 1 standard deviation. The PA contrasts were calculated as: ($PA_{region\ of\ interest}$ − $PA_{background}$)/$PA_{background}$. PA, photoacoustic; GI, gastrointestinal; SLN, sentinel lymph node.
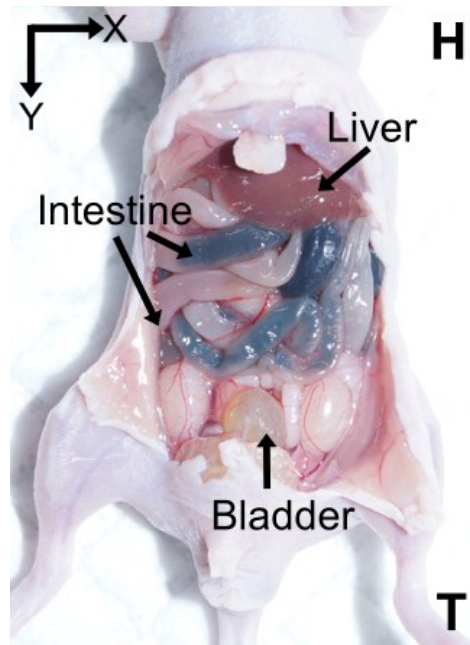
Fig. S8 Photograph of the dissected mouse acquired after *in vivo* PA imaging of GI tract. The GI tract is dyed black, the color of Bi$_2$Se$_3$ dispersion. PA, photoacoustic; GI, gastrointestinal; H, head; T, tail.