[0005] Accordingly, in one aspect, provided herein are compositions comprising: a photothermal agent, and one or more core particles, wherein the photothermal agent and the core particles are encapsulated in a nanoparticle made from a biodegradable material.

[0006] In some examples, the core particles are solid particles.

[0007] In some examples, the metal particles are Fe_3O_4 particles.

[0008] In some examples, the core particles are surface-modified for the attachment of the photothermal agent.

[0009] In some examples, the core particles are modified on the surface by oleic acid molecules.

[0010] In some examples, the photothermal agent is attached to the surface of the core particles through hydrophobic interactions with the oleic acid molecules.

[0011] In some examples, the core particles have a diameter of about 10 nm to about 40 nm.

[0012] In some examples, the composition comprises about 1 to about 10 core particles.

[0013] In some examples, the photothermal agent is selected from the group consisting indocyanine green (ICG), polydopamine, polyaniline (PANI), and polypyrrole (PPY).

[0014] In some examples, the photothermal agent is indocyanine green (ICG).

[0015] In some examples, the compositions described herein further comprise a therapeutic agent, wherein the therapeutic agent is encapsulated in the nanoparticle.

[0016] In some examples, the therapeutic agent is an anti-cancer therapeutic agent.

[0017] In some examples, the composition further comprises a tumor-targeting molecule attached to the surface of the nanoparticle.

[0018] In some examples, the tumor-targeting molecule is an antibody, or antigen-binding fragment thereof, that binds to a tumor-specific antigen.

[0019] In some examples, the diameter of the nanoparticle is about 70 nm to about 120 nm.

[0020] In one aspect, also provided herein are methods of producing any one of the compositions described herein, wherein the method comprises: (a) contacting one or more core particles with the photothermal agent, thereby attaching the photothermal agent to the surface of the core particles; (b) preparing a double emulsion comprising the biodegradable material; and (c) contacting the product of step (a) with the double emulsion prepared in step (b), thereby producing the nanoparticles encapsulating the core particles; thereby producing the composition.

[0021] In some examples, the biodegradable material is poly(lactic-co-glycolic acid)(PLGA).

[0022] In some examples, the double emulsion further comprises polyvinyl alcohol (PVA).

[0023] In some examples, the method further comprises washing and/or freezing the nanoparticles.

[0024] Also provided herein are methods of imaging a tumor tissue in a subject *in vivo*, the method comprising: (a) administering an amount of any one of the compositions described herein to the subject; (b) exciting the photothermal agent of the composition; and (c) detecting the emitted fluorescent signals, thereby imaging the tumor tissue. In one aspect, there is provided use of the composition described herein in the manufacture of an agent for imaging a tumor tissue in a subject *in vivo*, wherein: (a) an amount of the composition described herein is to be administered to the subject; (b) the photothermal agent of the composition is to be excited; and (c) the emitted fluorescent signals is to be detected, thereby imaging the tumor tissue.

[0025] In some examples, the quality of the imaging is enhanced compared to an imaging without the administration of the composition.

[0026] Also provided herein are methods of diagnosing a tumor in a subject, the method comprising: (a) administering an amount of any one of the compositions described herein to the subject; (b) exciting the photothermal agent of the composition; and (c) detecting the presence or absence of emitted fluorescent signals, thereby diagnosing the tumor. In one aspect, there is provided use of the composition described herein in the manufacture of an agent for diagnosing a tumor in a subject, wherein: (a) an amount of the composition described herein is to be administered to the subject; (b) the photothermal agent of the composition is to be excited; and (c) the presence or absence of emitted fluorescent signals is to be detected, thereby diagnosing the tumor.

[0027] In some examples, the methods described herein further comprise recording the intensity of the emitted fluorescent signals.

[0028] Also provided herein are methods of treating a subject having tumor, the method comprising: (a) administering an amount of any one of the compositions described herein to the subject; (b) exciting the photothermal agent of the composition, thereby increasing the temperature of the tumor cells that has internalized the composition and damaging the tumor cells, thereby treating the subject having the tumor. In one aspect, there is provided use of the composition described herein in the manufacture of a medicament for treating a subject having tumor, wherein: (a) an amount of the composition described herein is to be administered to the subject; (b) the photothermal agent of the composition is to be excited, thereby increasing the temperature of the tumor cells that has internalized the composition and damaging the tumor cells, thereby treating the subject having the tumor.

[0029] In some examples, the methods described herein further comprise treating the tumor with the therapeutic agent of the composition.

[0030] In some examples, wherein the therapeutic agent is a chemotherapy agent selected from the group consisting of paclitaxel, chlorambucil, cyclophosphamide, thiotepa, busulfan, purine antagonists, pyrimidine antagonists, folate antagonists, actinomycin D, doxorubicin, mitomycin, doxorubicin, mitoxantrone, and bleomycin.

[0031] In some examples, the tumor is a solid tumor.

[0032] In some examples, the photothermal agent is excited using a near-infrared (NIR) light.

[0033] In some examples, the methods described herein further comprise targeting a specific tumor type by the tumor-targeting molecule of the composition.

[0034] In some examples, the tumor is lung cancer.

[0035] In some examples, the subject is a human subject.

[0036] In some examples, the administration is selected from the group consisting of intravenous injection, intraperitoneal injection, oral administration, oral transmucosal delivery, subcutaneous administration, intradermal administration, and transdermal administration.

[0037] In some examples, the photothermal agent is degraded after emitting heat.

[0038] In some examples, the heat emitted from the photothermal agent is transmitted to the core particles, thereby increasing the heating duration.

[0039] In some examples, the heating of the tumor cells induces the apoptosis of the tumor cells.

[0040] In some examples, the composition is internalized into the tumor cells through non-specific endocytosis.

[0041] In some examples, the composition is internalized into the tumor cells through specific recognition of tumor antigens.

[0042] In some examples, the heating of the tumor cells is repeated at least once.

[0043] In some examples, the tumor cells are heated to about 40 °C to about 45°C.

[0044] Also provided herein are methods of evaluating a therapeutic effect in a subject undergoing treatment with one or more cancer therapy, the method comprising: (a) administering an amount of any one of the compositions described herein to the subject; (b) imaging a tumor area and determining the tumor size; (c) repeating the imaging and the determining of the tumor size at a later time point; and (d) evaluating the therapeutic effect based on the tumor size from the different time points; thereby evaluating the therapeutic effect in the subject. In one aspect, there is provided use of the composition described herein in the manufacture of an agent for evaluating a therapeutic effect in a subject undergoing treatment with one or more cancer therapy, wherein: (a) an amount of the composition described herein is to be administered to the subject; (b) a tumor area is to be imaged and the tumor size is to be determined; (c) the imaging and the determining of the tumor size is to be repeated at a later time point; and (d) the therapeutic effect is to be evaluated based on the tumor size from the different time points; thereby evaluating the therapeutic effect in the subject.

[0045] In some examples, the methods described herein further comprise imaging and determining the tumor size before the subject is treated with the cancer therapy.

[0046] In some examples, the repeating of the imaging and determining of the tumor size is performed after about 1 week to about 1 year.

[0047] In some examples, the imaging is X-ray computed tomography (CT), magnetic resonance imaging (MRI), magnetic particle imaging (MPI), photoacoustic imaging (PA), ultrasound imaging (US), fluorescent imaging (FL), or a combination thereof.

[0048] Also provided here are uses of photothermal nanoparticles for the imaging a tumor tissue in a subject *in vivo*, comprising: (a) administering an amount of the composition described herein to the subject; (b) exciting the photothermal agent of the composition; and (c) detecting the emitted fluorescent signals, thereby imaging the tumor tissue.

[0049] Also provided herein are uses of photothermal nanoparticles for the diagnosis of a tumor in a subject, comprising: (a) administering an amount of the composition described herein to the subject; (b) exciting the photothermal agent of the composition; and (c) detecting the presence or absence of emitted fluorescent signals, thereby diagnosing the tumor.

[0050] Also provided herein are uses of photothermal nanoparticles for treating a subject having tumor, comprising: (a) administering an amount of the composition described herein to the subject; (b) exciting the photothermal agent of the composition, thereby increasing the temperature of the tumor cells that has internalized the composition and damaging the tumor cells, thereby treating the subject having the tumor.

[0051] Also provided herein are uses of photothermal nanoparticles for evaluating a therapeutic effect in a subject undergoing treatment with one or more cancer therapy, comprising: (a) administering an amount of the composition described herein to the subject; (b) imaging a tumor area and determining the tumor size; (c) repeating the imaging and the determining of the tumor size at a later time point; and (d) evaluating the therapeutic effect based on the tumor size from the different time points; thereby evaluating the therapeutic effect in the subject.

[0052] Unless otherwise defined, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this disclosure belongs. Methods and materials are described herein for use in the present disclosure; other, suitable methods and materials known in the art can also be used. The materials, methods, and examples are illustrative only and not intended to be limiting. All publications, patent applications, patents, sequences, database entries, and other references mentioned herein are incorporated by reference in their entirety. In case of conflict, the present specification, including definitions, will control.

[0053] Other features and advantages of the disclosure will be apparent from the following detailed description and figures, and from the claims.

DESCRIPTION OF DRAWINGS

[0054] **FIG. 1** is a schematic illustration of the preparation and therapeutic functions of an example composition described herein (e.g., NJ001-ICG/OA Fe_3O_4 @PLGA).

[0055] **FIGs. 2A-2E** show the characterization of nanoparticles. **FIGs. 2A-2B** show he SEM and TEM images of ICG/OA-Fe_3O_4@PLGA; **FIG. 2C** shows the hydrodynamic diameter; **FIG. 2D** shows the zeta potential of ICG/OA-Fe_3O_4@PLGA; and **FIG. 2E** shows UV-visible full wavelength scanning of free ICG, free OA-Fe_3O_4 and ICG/OA-Fe_3O_4@PLGA nanoparticles.

[0056] **FIGs. 3A-3C** show that ICG/OA-Fe_3O_4@PLGA has constant high photothermal conversion efficiency. **FIG. 3A** shows the temperature rising curve of various NPs solutions for 18 hours; and **FIG. 3B** shows the larger version for 0-4 hours. **FIG. 3C** shows the temperature maps captured at key time points (0min, 1min, 2min, 3min, 5min, 10min, 20min, 30min, 1h, 2h, 3h, 5h, 10h, 15h, 18h) during the temperature monitoring process.

[0057] **FIG.4A** show the temperature changes of ICG/OA-Fe_3O_4@NPs, Blank-NP, free ICG, ICG@PLGA and ICG/Fe_3O_4@PLGA at the same ICG concentration (0.012mg/mL) under an 808 nm laser irradiation (1.0W/cm^2) for 51 cycles (3 min of irradiation followed by 7 min of cooling down for each cycle).

[0058] **FIG. 4B** shows the temperature maps captured at key time points (0min to 113min) during the temperature monitoring process of **FIG. 4A**.