Electronic Supplementary Material (ESI) for Chemical Society Reviews.

Table SI: List of organic photothermal agents used in cancer therapy

Therapeutic Agent		Photothermal Unit	Irradiation Parameters	Description of Use	Ref
1. Small Molecules based Photothermal agents	1.1 Cyanine	ICG	808-nm laser	ICG have been widely used to treat lung metastasis, targeted breast therapy, and prevent tumor recurrence at a relatively low-power laser irradiation.	1-4
		IR780	808 nm laser	IR 780 have been widely used to treat folate-overexpressed MCF-7 tumors, transferrin-receptor(TfR) overexpressing colon tumor cells and reverse drug resistance.	5-7
		IR825	808 nm laser	IR 825 have been widely used to treat deep-suited tumors, sentinel lymph nodes (SLNs) to inhibit tumor metastasis postsurgery and prevent tumor recurrence.	8-11
		Cypate	785 nm laser	Cypates have been used for precise tumor localization for enhanced PTT.	12, 13
		DiR	808 nm laser	DiR have been used in the suppression of lung metastasis.	14
		Asymmetric Cyanine, RC	915 nm laser	A novel organic dye RC with strong NIR absorption demonstrated excellent PCE (28.7%) under a 915 nm laser radiation.	15
	1.2 Porphyrin	Porphysomes	671 nm laser	Nanostructure-driven conversion from the PDT singlet oxygen generating mechanism of porphyrin to a completely thermal mechanism, ideal for PTT enhancement especially in a hypoxic solid tumor.	16
		Pyropheophorbide-a	690 nm laser	A smart ‘all-in-one’ nanoporphyrin that integrates NIRF/MR/PET/dual-PET-MR imaging guided PTT/PDT, as well as targeted drug delivery using a single wavelength NIR laser.	17

		Chlorin e6 (Ce6)	655 nm laser (2 W/cm^2, 2 min)	The intracellular acid-switchable micelles activated upon cellular uptake and intracellular dissociation in cancer cells resulting in significant ROS generation and hyperthermia.	[18]
		Tetraphenylporphyrin	635 nm laser (0.3 W/cm^2, 10 min)	A new supramolecular strategy for the fabrication of photothermal NDs by self-assembling of peptide-porphyrin conjugates as PA and PTT agents was demonstrated. Strong π-stacking in the assembled NDs revealed complete quenching of fluorescence and inhibition of ROS generation, resulting in a highly efficient light-to-heat energy conversion (PCE of 54.2%).	[19]
	1.3 Others	Bodipy	785 nm laser	The Bodipy dyes exhibited potent hyperthermia resulting in singlet oxygen-synergized PTT treatment under 785 nm irradiation.	[20]
		Phthalocyanine (Pc)	685 nm laser	A pilot study demonstrating the use of Pc monomers in PTT (unlike aggregates) via diversified structural modifications, including change in peripheral substituents, altering axial ligands, and changing central metal ions.	[21]
		Croc dye	808 nm laser	An effective nanoprobe for real time in vivo ratiometric photoacoustic pH imaging as well as pH responsive effective PTT was demonstrated.	[22]
2. CPNs		Polyaniline nanoparticles (PANPs)	808 nm laser	Intrinsic biological dopants sufficiently changed the polyanilines from emeraldine base (EB) to emeraldine salt (ES) resulting in the red-shifted absorption spectrum (from 545 nm to >700 nm), decrease in the band-gap energy and enhanced photothermal ablation of A431 cells under laser irradiation, excellent water soluble, high molar extinction coefficient and high PCE (48.5%) PANPs for cancer therapy.	[23, 24]
		PPy	808 nm laser	PPy NPs with excellent physiological stability, strong NIR absorption, and high magnetization, prolonged circulation time, and excellent tumor homing ability for imaging-guided PTT of cancer	[25, 26]
		D-A type SPNs	600-1100 nm laser	The synthesis of a biodegradable SPN based on the enzymatically oxidizable nature of vinylene bonds and polymer chemistry for enhanced PA and PTT based cancer	[27-32]

			therapy, development of the first organic photothermal nanoagent with the dual-peak absorption in both NIR-I and NIR-II windows for cancer PTT (1064 nm), excellent singlet oxygen ($^1O_2$) quantum yield (40%) and high PCE (37.1%) under single-laser irradiation (635 nm), excellent PCE combined precise tumor targeting capability (660nm), higher extinction coefficients for faster PTT and deeper tumor tissue imaging (808 nm).	
	PDA	808 nm laser	The PDA formulation exhibited excellent biocompatibility and little toxicity, as well as high ROS generation and high photothermal conversion efficiencies under the laser irradiation of 808 nm, triple-negative breast cancer regression at relatively low dose, and overcome multidrug-resistance.	33-36

Abbreviations: donor-acceptor(D-A), polydopamine (PDA), boron dipyrromethene (Bodipy), croconaine (Croc), 1,1-dioctadecyl-3,3,3,3-tetramethylindotricarbocyanine iodide (DiR), sentinel lymph nodes (SLNs), semiconducting polymer nanoparticles (SPNs), polypyrolle (PPy)

Table S2: A list of abbreviations and their corresponding full names.

aPTT	adjuvant Photothermal therapy
ALP	Alkaline phosphatase
BBD	Boronate-caged boron-dipyrromethene dye
BCS	Breast-conserving surgery
BHQ	Black hole quencher
CAR	Chimeric antigen receptor
CCCM	Cracked cancer cell membranes
CD	Cyclodextrin
CP	Conjugated polymers

CPNPs	Conjugated polymer nanoparticles
CPQ	Cleavable peptide linker
CT	Computed tomography
CTC	Circulating tumor cells
CTAB	Cetyltrimethylammonium bromide
CTLA	Cytotoxic T-lymphocyte antigen
CW	Continuous wave
CuS	Copper sulfide
Cy	Cyanine
CW	Continuous wave
DA	Dimethylmaleic anhydride
D-A	Donor-Acceptor
Dox	Doxorubicin
DPP	Diketopyrrolopyrrole
DTPA	Diethylene triamine pentaacetic acid
EB	Emeraldine base
ECM	Extracellular matrix
EPR	Enhanced permeability and retention

ES	Emeraldine salt
FRET	Fluorescence resonance energy transfer
GEM	Gemcitabine
GFP	Green fluorescent proteins
GSH	Glutathione
HA	Hyaluronic acid
HCP	Hyperbranched conjugated polymer
HPE	Hyperbranched polyether
HIF	Hypoxia-inducible factor
HNSCC	Head and neck squamous cell carcinoma
HSA	Human serum albumin
ICG	Indocyanine green
ICP-OES	Inductively coupled plasma optical emission spectroscopy
ICT	Intramolecular charge transfer
LCST	Lower critical solution temperature
LSPR	Localized surface plasmon resonance
MB	Microbubble
MDR	Multiple drug resistance

MMPs	Matrix metalloproteinases
MPE	Maximum permissible exposure
MPS	Mononuclear phagocyte system
MRD	Microscopic residual disease
MRI	Magnetic resonance imaging
MSOT	Multispectral optoacoustic tomography
NAC	N-acetyl-l-cysteine
NHS	N-hydroxysulfosuccinimide
NIR	Near-infrared region
NP	Nanoparticle
OCT	Optical coherence tomography
PACT	Photoacoustic computed tomography
PAE	Photoacoustic endoscopy
PAH	Poly(allylamine hydrochloride)
PAI	Photoacoustic imaging
PAM	Photoacoustic microscopy
PANI	Polyaniline
PAT	Photoacoustic tomography
PCE	Photothermal conversion efficiency

PCL	Poly(ε-caprolactone)
PDA	Polydopamine
PDI	Perylene diimide
PEARL	Photothermal enhancing auto-regulated liposomes
PEG	Polyethylene glycol
PEI	Polyethyleneimine
PET	Positron emission tomography
PEDOT	poly(3,4ethylenedioxythiophene)
PFC	Perfluorocarbon
PLGA	Poly(lactic-co-glycolic acid)
PLTs	Platelets
PNBs	Plasmonic nanobubbles
POM	Polyoxometalate
PPy	Polypyrrole
PS	Photosensitizer
PSS	Poly(4-styrenesulfonate)
PTA	Photothermal transduction agents
PTT	Photothermal therapy

PTX	Paclitaxel
QY	Quantum yield
RGD	Arginine-glycine-aspartic acid
RC	Alkyl radical
ROC	Alkoxyl radical
ROS	Reactive oxygen species
SERS	Surface-enhanced Raman spectroscopy
SLN	Sentinel lymph node
SO	Singlet oxygen
SOA	Semiconducting oligomer amphiphile
SON	Semiconducting oligomer nanoprobes
SP	Semiconducting polymers
SPA	Sonophotoacoustics
SPECT	Single photon emission computed tomography
SPNP	Semiconducting polymer nanoparticles
SWNH	Single walled carbon nanohorn
Tf	Transferrin
TMD	Transition metal dichalcogenides

TME	Tumor microenvironment
TMO	Transition metal oxides
TPA	Triphenylamine
TRPL	Time-resolved photoluminescence
UCNP	Upconversion nanoparticle

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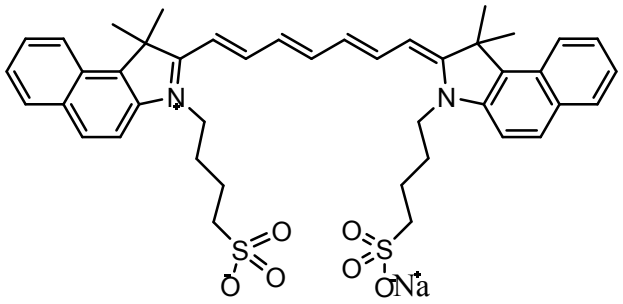
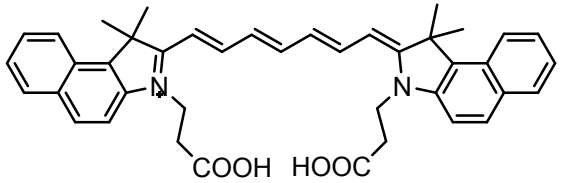
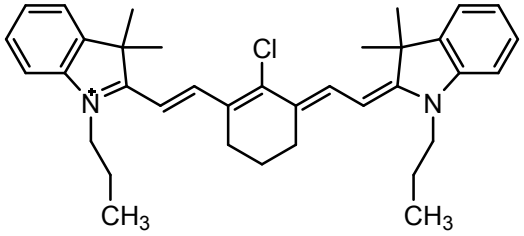
S1. Cyanine dye



Indocyanine green (ICG)



Cypate



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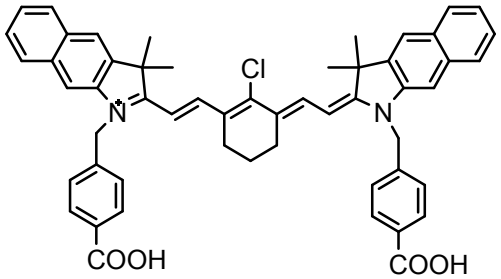

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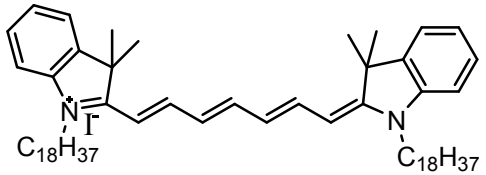
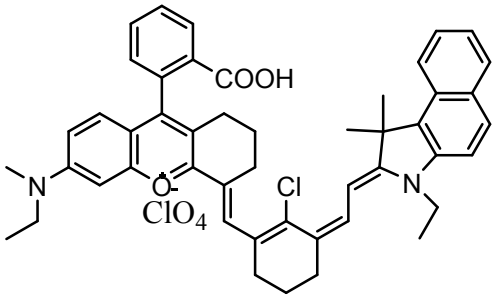
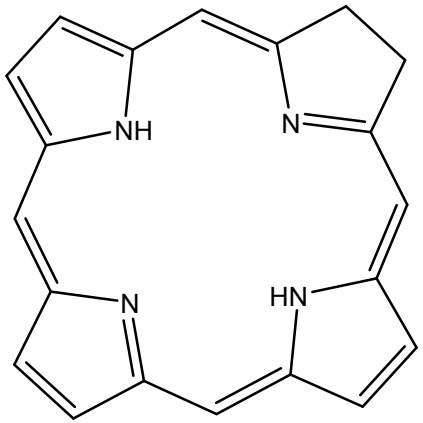


DiR

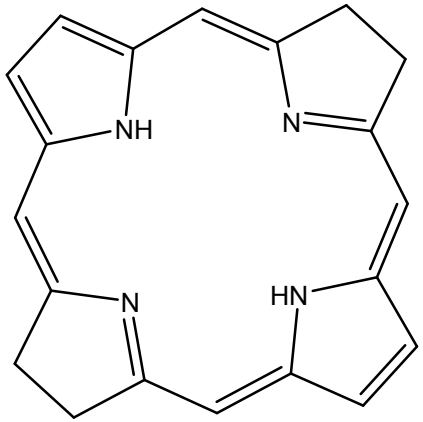


New RC cyanine

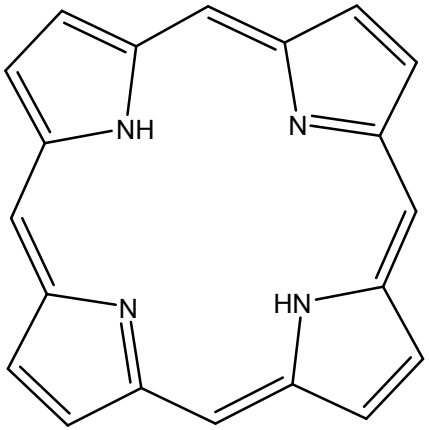
S2. Porphyrin



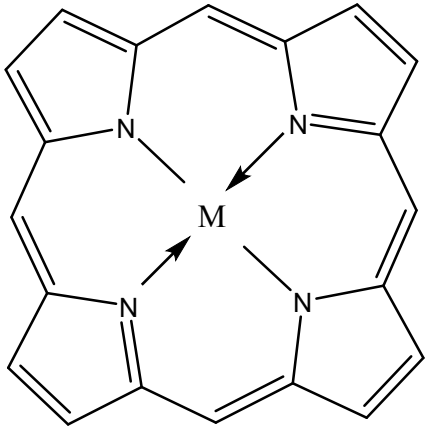
Chlorin



Bacteriochlorin

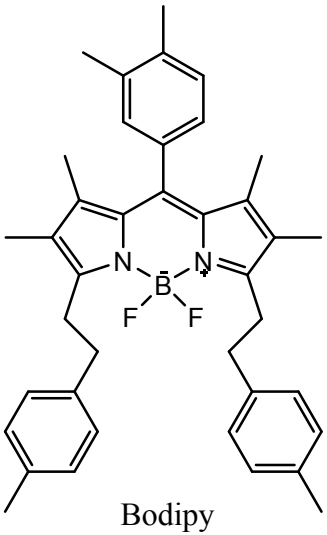


Free base porphyrin

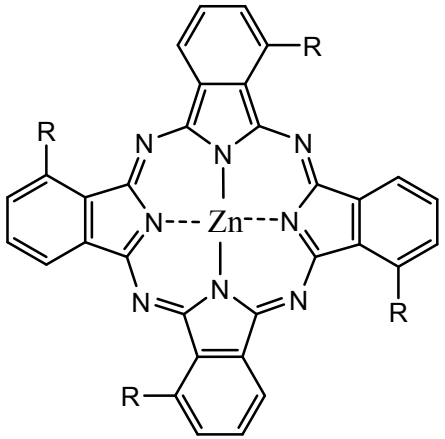


Metal-chelated porphyrin

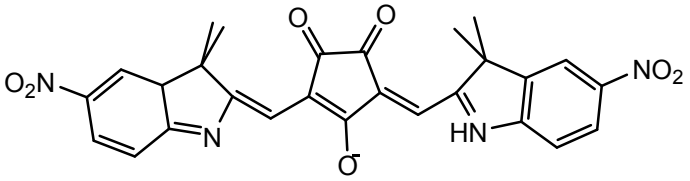
S3. Other Small Molecules



Bodipy

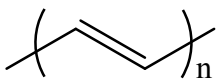


Phthalocyanine

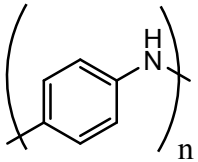


Croconaine dye

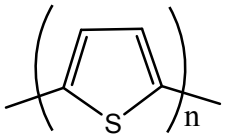
S4. Conjugated Polymers



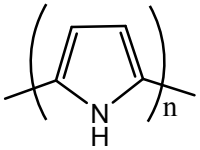
Polyacetylene (PA)



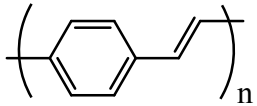
Polyaniline (PANI)



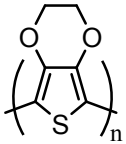
Polythiophene (PT)



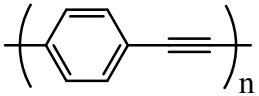
Polypyrrole (PPy)



Poly(p-phenylene vinylene) (PPV)



Poly (3,4-ethylenedioxythiophene) (PEDOT)



Poly(p-phenylene ethynylene) (PPE)