

Supplementary Information

Recent Development of Carbon Dots Regarding their Photophysical Properties, Photoluminescence Mechanism, and Core Structure

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Table 1: Summary of select carbon dots preparation methods and their optical properties. Cell line refers to the type of cells with which the carbon dots were tested.

Year	Precursors			Preparation			Optical Properties				Cell Line	Reference
				Thermal	Radiation	Oxidation	UV-vis	Fluorescence	Quantum Yield (reference-%)	Lifetime		
2008	Carbon nanoparticles	Zinc acetate	NaOH		Laser Ablation	Nitric Acid	abs. 430 nm, UV abs.	510 nm (ex 440 nm)	45% (quinine sulfate-54%)	--	--	1
2009	SiO ₂	F127 Polymer Composite	Polyethylene glycol	66 °C (48 hrs)			Broad UV abs	450 nm (ex 360 nm)	14.7%(--)	--	E. coli ATCC 25922	2
2010	Octadecene	1-hexadecylamine	Citric Acid	300 °C (5 min)			abs. 280,360 nm	450 nm (ex 360 nm)	53% (quinine sulfate-54%)	--	--	3
2010	Activated Carbon	Amine terminated compounds				Nitric Acid	abs. 360 nm	440 nm (ex 360 nm)	12.6% (--)	--	COS-7	4
2011	Glucose (1)	Monopotassium Phosphate (36)	Water	200 °C (12 hrs)			Broad UV abs	435 nm (ex 350 nm)	2.4% (--)	2.0 ns	--	5
2011	Glucose (1)	Monopotassium Phosphate (26)	Water	200 °C (12 hrs)			Broad UV abs	510 nm (ex 440 nm)	1.1% (--)	1.8 ns	HepG2	5
2011	Watermelon Peel			220 °C (2 hrs)			Broad UV abs	540 nm (ex 430 nm)	7.1% (quinine sulfate-54%)	5.72 ns	--	6
2013	Ammonium Citrate	Water		160 °C (6 hrs)			abs. 235,327 nm	437 nm (ex 365 nm)	13.5% (quinine sulfate-54%)	10.6 ns	--	7
2013	Banana Juice	Ethanol		150 °C (4 hrs)			abs. 283 nm	460 nm (ex 360 nm)	8.95% (quinine sulfate-54%)	--	--	8
2013	b-polythetylenimine	Ammonium persulfate		210 °C (10 hrs)			abs. 335 nm	460 nm (ex 360 nm)	54.3% (quinine sulfate-54%)	4.8 ns	MCF-7 and 293T	9
2014	Citric Acid	Urea			650 W (5 min)		abs. 336 nm	440 nm (ex 360 nm)	15% (--)	--	--	10
2014	Milk			180 °C (2 hrs)			abs. 280 nm	454 nm (ex 360 nm)	12% (quinine sulfate-54%)	1.61 ns	U87	11
2014	L-tartaric acid	Luaryl chloride	D-glucose	3 step				460 nm (ex 375 nm)	16.5% (quinine sulfate-54%)	--	CHO	12

2015	β-cyclodextrin	Polyethylenimine	Phosphoric acid	90 °C (2 hrs)			abs. 250,320 nm	510 nm (ex 390 nm)	30% (fluorescein-79%)	--	H1299	13
2015	Glycolic Acid	Urea	Water	250 °C (1 hrs)			abs. 270,320 nm	430 nm (ex 365 nm)	12.9 % (--)	3.2 ns	MG-63	14
2015	Malic Acid	Urea	Water	250 °C (1 hrs)			abs. 270,320,420 nm	462 nm (ex 365 nm)	32.4 % (--)	4.4 ns	MG-63	14
2015	Citric Acid	Urea	Water	250 °C (1 hrs)			abs. 270,320,420 nm	514 nm (ex 365 nm)	54.9 % (--)	6.7 ns	MG-63	14
2015	Graphite	Polyethylene glycol			Laser Ablation		abs. 205,260 nm	325,405 nm (280,340 nm)	--	15.7,6.6 ns	--	15
2015	C3N4	ethanediamine		80 °C (12 hrs)			abs. 250,270 nm	370,470 nm (270,385 nm)	21% (quinine sulfate-54%)	2.23 ns	HeLa and in mice	16
2015	Citric Acid	Ammonia Hydrate		200 °C (5 hrs)			abs. 245,336 nm	442 nm (ex 350 nm)	40.5% (quinine sulfate-54%)	9.03 ns	PC14	17
2015	Urea	p-phenylenediamine		160 °C (10 hrs)			abs. 255,282,383 nm	440 nm (ex 370 nm)	21.23% (--)	8.94 ns	HeLa	18
2015	Urea	p-phenylenediamine		160 °C (10 hrs)			abs. 255,282,410 nm	517 nm (ex 410 nm)	8.53% (--)	10.05 ns	HeLa	18
2015	Urea	p-phenylenediamine		160 °C (10 hrs)			abs. 255,282,488 nm	566 nm (ex 490 nm)	27.57% (--)	9.30 ns	HeLa	18
2015	Urea	p-phenylenediamine		160 °C (10 hrs)			abs. 255,282,528 nm	625 nm (ex 525 nm)	23.81% (--)	9.41 ns	HeLa and nude mice	18
2015	Citric Acid	Trisaminomethane		160 °C (10 min)			abs. 333 nm	417 nm (ex. 333 nm)	93.3% (quinine sulfate-54%)	19.5 ns	--	19
2015	Alanine	Ethylenediamine	Water	200 °C (6 hrs)			abs. 320 nm	390 nm (ex. 320 nm)	46.2% (quinine sulfate-54%)	4.43 ns	MCF-7	20
2016	Citric Acid	L-cysteine		200 °C (3 hrs)			abs. 242,345 nm	418 nm (ex 342 nm)	64% (quinine sulfate-54%)	9.00 ns	--	21
2016	Citric Acid	Ethylenediamine	Boric Acid		700 W (2 min)		abs. 241,351 nm	450 nm (ex 350 nm)	67.6% (quinine sulfate-54%)	9.74 ns	--	22
2016	Carrot juice	Water		160 °C (6 hrs)			abs. 254,320 nm	442 nm (ex 360 nm)	5.16% (quinine sulfate-54%)	--	HaCaT	23
2016	Citric Acid	Ethylenediamine	NaBH4	200 °C (4 hrs)			abs. 250,340 nm	460 nm (ex 340 nm)	40.69 % (--)	--	--	24
2016	Citric Acid	Ethylenediamine	NaBH4	200 °C (4 hrs)			abs. 250,300,440 nm	530 nm (ex 300 nm)	69.30% (--)	--	--	24
2017	Citric Acid	N-(2-hydroxyethyl) EDA	Water		800 W (20 min)		abs. 330 nm	447 nm (ex 351 nm)	79.63% (quinine sulfate-54%)	--	--	25
2017	Citric Acid	Poly(ethylenimine)	Water	110 °C (2 hrs)			abs. 252,358 nm	459 nm (ex 360 nm)	48.3% (quinine sulfate-54%)	--	--	26
2017	Citric Acid	AEAPMS	Ethanol	220 °C (5 min)			abs. 240,360 nm	610 nm (ex 460 nm)	19% (--)	12.29 ns	--	27

2017	Aspartic Acid	Water		180 °C (18 hrs)			abs. 275,362 nm	402 nm (ex 340 nm)	41.3% (quinine sulfate-54%)	--	--	28
2017	Citric Acid	AEAPMS	Ethanol	220 °C (3 min)			abs. 260,360 nm	580 nm (ex 460 nm)	37% (--)	12.545 ns	--	29
2017	Casein			180 °C (4 hrs)			abs. 270,375 nm	446 nm (ex 383 nm)	31.8% (quinine sulfate-54%)	--	HeLa	30
2017	Citric Acid	Ethylenediamine (+EDC)	Phosphoric acid	250 °C (2 hrs)			abs. 346,450 nm	430,500 nm (340,450 nm)	30,78% (QS, flourescein)	--	RAW 264.7 and in mice	31
2017	BSA	Water		195 °C (6 hrs)				460 nm (ex 390 nm)	44% (quinine sulfate-54%)	--	Haematococcus Pluvialis	32
2017	Citric Acid	Diethylenetriamine	Water		700 W (3 min)		abs. 256,350 nm	480 nm (ex 360 nm)	4% (quinine sulfate-54%)	12.8 ns	PC-3	33
2017	Aminosalicylic Acid	Ethanol		200 °C (18 hrs)			abs, 292,455,540 nm	516 nm (ex 360 nm)	16.4 % (Rhodamine B-56%)	6.7 ns	H1299	34
2017	Diammonium citrate			180 °C (1 hrs)			abs. 337 nm	440 nm (ex 350 nm)	11.21% (quinine sulfate-54%)	--	--	35
2017	Citric Acid	(NaNO ₃ ,KNO ₃ ,Na NO ₂)	(7:53:40 ratio)	220 °C (6 hrs)			Broad UV abs	375 nm (ex 310 nm)	20.8% (quinine sulfate-54%)	6.59 ns	HeLa	36
2017	Citric Acid	Ethylenediamine		160 °C			abs. 242,332 nm	450 nm (ex 350 nm)	33.7% (quinine sulfate-54%)	14 ns	--	37-38
2017	Sesame Seeds				800 W (15 min)		abs. 275 nm	440 nm (ex 365 nm)	8.02% (quinine sulfate-54%)	3.36 ns	--	39
2017	Polyacrylic Acid	Ethylenediamine	Water	200 °C (8 hrs)			abs. 326 nm	410,450 nm (340,380 nm)	44.18% (--) (em2)	6.13,5.05 ns	--	40
2017	Folic Acid	Polyethyleneimine (1800)		180 °C (6 hrs)			abs. 272,356 nm	452 nm (ex 370 nm)	42% (quinine sulfate-54%)	8.19,4.00 ns	293T and HeLa	41
2017	Honey						abs. 280 nm	456 nm (ex. 360 nm)	1.6% (quinine sulfate-54%)	4.67 ns	--	42

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