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APPENDICES

APPENDIX A







D:\DATA\SUMANA\Kam\20-02-14\B-Ph+di\0_H12\1

Figure A-2: MALDI-TOF-mass spectrum of compound 1



Figure A-3: ¹H-NMR spectrum of compound 2



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Mass Spectrum List Report

Figure A-5: HR-ESI-mass spectrum of compound 2











D:\DATA\SUMANA\Kam\20-02-14\BB-Ph+di\0_H6\1









Mass Spectrum List Report

Figure A-11: HR-ESI-mass spectrum of compound 3b





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19 670 1222 9429 8.5 24.4 0.1151 5820 20 671 129 34873 316 92.2 0.1083 6195 21 672 1226 13972 12.6 36.5 0.1061 6333 22 673 0997 10872 9.8 28.3 0.1169 5760 23 685 1362 24.8 0.1004 6826 24 686 1392 11838 10.7 30.8 0.1075 6381 25 687 1136 13474 12.2 35.2 0.1173 5859 26 699 1590 23039 20.8 60.7 0.1024 6343 27 700 1540 11209 10.1 29.2 0.1081 6477 28 701 13615 11801 10.7 30.8 0.1071 6661 30 715 1382 11863 10.7 30.9 0.1145 6246	18 65	57 1197	18728	16.9	49.2	0 1 1 8 9	5526						
20 671 1229 543 3 3 0 52.2 0 1063 6333 22 673 0997 10872 9 8 28 3 0 169 5780 23 685 1436 26662 24 1 70 0 1004 6826 24 686 1392 11838 10 7 30.8 0 1075 6381 25 687 1136 13474 122 35.2 0 1173 5859 26 699 1590 23039 20.8 607 0 1102 6343 27 700 1540 11209 10 12.2 10 112 6477 28 701 1282 13414 12 135.1 0 1134 6185 29 713 1675 11801 10.7 30.8 0 1071 6661 30 715 1382 11863 10.7 30.9 0 1145 6246 <td>19 67</td> <td>0 1222</td> <td>9429</td> <td>8.5</td> <td>24.4</td> <td>0.1151</td> <td>5820 6195</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>	19 67	0 1222	9429	8.5	24.4	0.1151	5820 6195						
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26 699 1590 23039 20.8 60.7 0.1102 6343 27 700 1540 11209 10.1 29.2 0.1081 6477 28 701 1282 13414 12.1 35.1 0.1134 6185 29 713 1675 11801 10.7 30.8 0.1071 6661 30 715 1382 11863 10.7 30.9 0.1145 6246	25 68	7 1136	13474	12 2	35 2	0 1173	5859						
28 701 1282 13414 121 351 0 1134 6185 29 713 1875 11801 107 30.8 0 1071 6661 30 715 1382 11863 10.7 30.9 0 1145 6246	26 69	9 1590	23039	20 8	60 7 29 2	0 1102	6343 6477						
29 713 1675 11801 10 7 30 8 0 1071 6661 30 715 1382 11863 10 7 30 9 0 1145 6246	28 70	1 1282	13414	12 1	35 1	0 1134	6185						
30 /151382 11863 UL EUE Control 200	29 71	3 1675	11801	107	30.8	0 1071	6661						
	30 71	13 1302	11003	10.7	50.5	01103							

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Figure A-14: HR-ESI-mass spectrum of compound 3c

AT 2756 **รับเดือนปี** <u>16 ส.ค. 7560</u>

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Analysis Info Analysis Name Method Sample Name	B OSCU MKE B-DPI B-DPI	JJS56092 turne_wid VI-Thio VI-Thio	40021 e_2013	d 10204.m				Acquisition Date Operator Instrument	9/24/2013 4:08 Administrator micrOTOF	29 PM 72
Acquisition P Source Type Scan Range Scan Begin Scan End	Parameter ESI n/a 50 m/ 3000	z m/z		lon Po Capilla Hexap Skimm	arity ny Ext ole RF er 1	Positi 150 0 300 0 45 0 1 25 0 1	ve V V	Sel Correcto Sel Puisar Pi Set Puisar Pi Set Reflector Set Flight Tu Set Detector	r Fill 75 V ull 398 V ush 380 V 1300 V be 9000 V TOF 1910 V	
intens x10	8,5 6-			Hexap		230	549.1776		+MS, 1.0-1 0	mın #(58-60
	4-	2607	455 1	376479.20	41 507	1887			656 3468	
	400	2001	450		500		550	600	650	m
# 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 9 20 21 22 23 24 25 26 27 28 30	m/z 413 2607 443 2285 455 1376 479 2041 487 3557 508 1921 507 1887 508 1916 523 2602 548 1801 544 2209 548 1801 549 1776 550 1794 551 1789 564 1537 567 1530 568 1527 567 1530 567 2808 572 2519 581 1375 611 13108 655 3425 655 3426	1 11058 7081 13033 11519 8551 7154 8795 12090 6879 8306 7277 8306 7277 8306 7272 8306 7272 153156 678909 203054 56498 10658 10658 10761 50917 16498 8677 7890 65137 6234 8356	1%, 166 10 19 17 13 11 13 58 18 10 10 12 11 13 58 18 10 10 226 0 10 226 0 10 226 0 10 226 0 12 20 0 12 20 0 9 12	S/N4 177.5 888 1509 1148 813 658 758 813 648 556 648 556 648 556 648 556 641 512 11958 53098 15996 4467 843 899 4292 1394 686 6321 5194 643 899 4292 1394 686 632 1394 638 637 34 716 638 731 913 1237	FWHHM 0 0532 0 0520 0 0549 0 0584 0 0693 0 0613 0 0613 0 0613 0 0643 0 0643 0 0642 0 0643 0 0664 0 0664 0 0664 0 06637 0 0664 0 06637 0 0664 0 06637 0 0664 0 06637 0 0664 0 06637 0 0664 0 06837 0 0664 0 06847 0 0664 0 06847 0 0664 0 06847 0 0847 0 0847	Rea. 7765 6531 8284 6911 8348 6712 8342 8278 8686 6132 8215 8390 8254 849 8255 8649 8255 8649 8255 8649 8254 8372 8372 8372 8449 8256 8372 8372 8372 8372 8372 8372 8372 8372				
Bruker Dalton	ics DataA	nalysis 3.	3		pri	nted: 9	0/24/2013 4	18-15 PM	Page	1 of 1

Mass Spectrum List Report

Figure A-17: HR-ESI-mass spectrum of compound 4b



Figure A-18: ¹H-NMR spectrum of compound 13a



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Figure A-20: ¹H-NMR spectrum of compound 13b



Analysis Info Analysis Name	oscu	JK57010	7003 d					Ao	quisition Date	1/9/	2014 11:24	4:34 AM
Method Sample Name	Natee2 DPM-1 DPM-1	20130403 Thio Thio	lim					Op Ins	erator trument	Mici	rOTOF	72
Acquisition Pa	raineter								Set Correcto	r Fill	75 V	
Source Type Scan Range Scan Begin Scan End	ESI n/a 50 m/z 3000 n	n/z		Capillar Capillar Hexapo Skimmo Hexapo	arity y Exit ile RF ar 1 ile 1	150 0 V 400 0 V 54 4 V 21 4 V			Set Pulsar P Set Pulsar P Set Reflecto Set Flight Tu Set Detector	ush r ibe TOF	398 V 380 V 1300 V 9000 V 1910 V	
Intens		-				603.0	075				MS 0 3-0 3	min #(19-20
#10 ⁰						503	A12					
8 0												
0.6												
04												
0.2												
0.2							í.					983 4678
	0	100	200	300	400	500)	600	700	800	900	m
		1.0	-		C740.144							
1	m/z 145 1842	3681	0.4	S/N 9.5	0 0144	10099						
2	413 2663	7306	0.8	21.0	0.0619	6674						
3	435 1746	15649	1.7	45.2	0.0689	6314						
	436 1774	9351	1.0	26.8	0 0707	6466						
6	479.2014	13424	1.5	38 6	0 0791	6061						
7 -	480.2041	4490	05	12.6	0.0753	6379						
8 4	481.2144	24773	2.7	211	0.0740	6295						
10	501 1836	6365	07	18.1	0.0761	6584						
11	503 1975	920239	100.0	2675.2	0 0791	6364						
12	504 2007	275983	30.0	802.0	0.0741	6804 6658						
13	506 1985	13248	14	38.1	0 0766	6612						
15	519 1706	128507	14.0	373 0	0.0774	6708						
16	520.1734	36770	40	106.4	0 0765	6802						
17 1	521.1707	18845	20	54 3	0.0757	6894						
19	535 1372	6946	0.8	197	0 0895	5978						
20	537 1380	3761	0.4	10.4	0 0884	6078						
21 1	585 1850	3692	1.4	10.6	0.0813	4891						
23	984 4683	8412	0.9	24.8	0.1948	5053						
24	985 4678	4307	0 5	12 6	0 1964	5017						
25 1-	450 6518	4386	0.5	12.8	0 0277	52398 17949						
27 2	352 6152	5813	06	16.3	0.0329	71550						
28 2	352 8200	5171	06	14.5	0.0567	41495						
29 23	352 8849	3906	04	10 9	0.0380	20542						
34 UL		0.01				`						
											0	1 of 1

Mass Spectrum List Report

Figure A-22: HR-ESI-mass spectrum of compound 13b





Analysis Info											
Analysis Name Method Sample Name	OSCU Natee2 DPM-2	JK570107 20130403 T	7002.d .m					Acquisition Da Operator Instrument	ate 1/9/ Adr mic	ninistrator rOTOF	9:46 AM 72
Acquisition Par Source Type Scan Range Scan Begin Scan End	rameter ESI n/a 50 m/z 3000 m	νz		lon Po Capilla Hexap Skimn Hexap	larity ary Exit ole RF her 1 hole 1	Posi 150. 400. 54.4 21.4	tive 0 V 0 V V	Set Com Set Puls Set Puls Set Refit Set Fligh Set Dete	ector Fill ar Pull ar Push ector nt Tube ector TOF	75 V 398 V 380 V 1300 V 9000 V 1910 V	
Intens	[58	5 1851			MS. 1.2-1.2	min #(69-70
x10 ⁻³						50.	1851				
2.5											
2.0											
1.5											
1.0							1				
0.5	62 7072	145 1840		39	2.0773		1.				
	0	20	0		400		600	800	10	000	m
	m/z	3451	1%	S/N 9.8	FWHM 0.0087	Res. 6175					
2	145 1849	3517	12	10.0	0.0131	11078					
3	297 7101	3485	12	10 9	0 0137	21757					
4	370 0945	5244	1.8	16.8	0.0546	6775					
6	392.0773	8268	2.9	26.5	0.0618	6348					
7	427 1871	7250	25	23 0	0.0645	6395					
9	504 5857	3114	1.1	9.5	0 0175	28901					
10	504 7206	3341	12	102	0.0312	16174					
11	562 1910	4972	17	15.5	0.0825	6818					
13	563 2011	13786	4.8	43.8	0.0806	6984					
14	564 2030	4886	17	15 3	0.0821	6711					
16	586 1877	91014	31.8	295 4	0.0871	6730					
17	587 1844	36697	12.8	119.0	0.0875	6708					
18	588 1867 601 1603	19810	69	64 6	0 0895	6715					
20	602 1638	6634	23	21.4	0 0931	6466					
21	603 1578	4072	14	13.0	0.0945	6383 29340					
23 1	450 8951	4006	14	13.2	0.1900	7636					
24 1	500 8299	3211	11	10.8	0.0302	49635					
25 1	709 1762 874 5095	3152	12	11.5	0.0311	60201					
27 2	352 6021	4995	1.7	16 0	0.0336	69958					
28 2	352 8191	4785	1.7	15.3	0.0510	46176					
30 2	885 2850	3293	12	11 2	0.0512	56309					
Bruker Daltonic	s DataAn	alysis 3.3			pri	nted	1/9/2014	11:28:58 AM		Page	1 of 1

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Figure A-25: HR-ESI-mass spectrum of compound 13c





Figure A-26: ¹H-NMR spectrum of compound 5



Figure A-27: ¹H-NMR spectrum of compound 14a



D::/DATA/SUMANA/Zn2AP/20-02-14/Ox-DPM-Ph+di (2)/0_H8/1



Figure A-29: MALDI-TOF-mass spectrum of compound 14a



Figure A-30: ¹H-NMR spectrum of compound 14b



Analysis Info Analysis Name Method Sample Name	OSGK56071001 d Tune_wide_POS_Natee20130403 m B-Ox-ester B-Ox-ester								Acquisition Operator Instrument	Date	e 7/10/2013 6:23:20 PM Administrator micrOTOF 72			
Acquisition Par Source Type Scan Range Scan Begin Scan End	ESI Ion Pol n/a Capila 50 m/z Hexapi 3000 m/z Skimm Hexap			lotar#y Positive #ary Exit 150.0.V spola RF 250.0.V mer 1 45.0.V spole 1 24.3.V				Set C Set P Set R Set R Set R Set D	orrector ulsar Pu ulsar Pu eflector ight Tub elector 1	Fill 33 V ill 386 V ish 368 V 1300 V be 9000 V TOF 2450 V				
Intens x10 ⁵	-					49	3 1202					•MS	0 5min #(28)	
15														
10														
				301.13	413	2670								
0.5			245	0761	30									
	56.3709	145.489	6				1		7	66 0209	8	77.8818 96	3 2501	
	Ó '	100	200	300	40	0	500	600	700	80	0	900	1000 m/2	
	m/z	1	1%	SAN	FWHM	Res								
1	56 3709	2914	16	12.3	0 0097	5840								
2	245 0761	19815	11.1	85.7	0.0456	5625								
4	302 1433	6310	3 5	27 2	0 0497	6074								
5	313 1787	4701	26	20 2	0 0544	5759								
6	332 8953	2929	16	12.5	0.0670	5065								
8	363 2035	2986	1.7	13.0	0 0634	5730								
9	393 2982	4049	23	18.1	0 0756	5204								
10	413 2670	64330	35 9	296.4	0.0680	6111								
12	421 2353	4321	2.4	197	0 0787	5349								
13	47 0785	3749	21	17.4	0 0671	6667								
14	448 0817	2994	17	138	0.0222	5845								
10	176 2397	3222	18	15 2	0 0175	27259								
17	493 1202	179038	100 0	876 1	0 0917	5375								
18 -	494 1233	43066	24.1	210.6	0.0911	5585								
20	505 1577	3228	18	15.6	0 1167	4330								
21	766.0209	3693	21	212	0 0230	33334								
22	963 2501	/631	- 43	25.1	0 1295	7444								
24 1	124 4580	3054	17	16 5	0 0276	40774								
25 1	213 5620	3106	17	16 0	0 0 3 4 5	35156								
26 1	450 7508	3956	22	19.6	0 0242	59945								
28 2	351 8355	5577	31	27 1	0.0337	69837								
29 2	352 1233	2970	17	14.3	0 0921	25527								
30 2	884 1160	3345	19	15.8	0.0809	10090								
30 2	884 1160	3345	19	15.8	0.0808	35686								
Bruker Daltonic	s DataAna	alysis 3.3			pni	nted	7/11/2	013 10:3	8:07 AM	-	-	Page	1 of 1	

Mass Spectrum List Report

Figure A-32: HR-ESI-mass spectrum of compound 14b

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Figure A-33: ¹H-NMR spectrum of compound 14c



Analysis Info Acquisition Date 11/5/2013 12:21 39 PM OSCUJS561105001.d Analysis Name Operator Instrument Administrator Natee20130403.m Method micrOTOF 72 Ox-DPM-2T Sample Name Ox-DPM-2T Set Corrector Fill Set Pulsar Pull Set Pulsar Push Set Reflector Set Flight Tube Set Detector TOF 75 V Acquisition Parameter Positive 200.0 V 400.0 V 54.4 V 21.4 V 398 V 380 V Ion Polarity Source Type Scan Range Scan Begin Scan End ESI Capillary Exit Hexapole RF Skimmer 1 n/a 50 m/z 3000 m/z 1300 V 9000 V 1910 V Hexapole 1 +MS, 1 1min #(63) Intens x10⁴ 581 3553 575 1059 567.2969 597.3378 553 3125 1.0 601.0219 591.0768 0.5 561.3943 600 570 580 590 550 580 1% 28.0 9.1 S/N 39.0 12.3 FWHM 0.0809 0.0812 0.0636 0.0647 0.0663 0.0794 0.0894 0.0847 0.0847 0.1070 0.0833 Res. 6787 5100 6872 6773 6833 6215 6011 m/z 413.2654 414.2648 437 1931 438 1965 453 1691 493 3068 537 3296 553 3125 567 2969 575 1059 581 3553 597 3378 24955 2 3 4 5 6 7 8 9 10 11 12 13 14 15 6 17 18 19 20 21 22 23 24 25 26 27 89224 22127 14337 9975 $\begin{array}{c} 140.5\\ 34.5\\ 22.2\\ 16.6\\ 113.7\\ 16.7\\ 17.1\\ 18.9\\ 49.8\\ 97.2\\ 38.9\\ 97.2\\ 38.9\\ 83.0\\ 20.1\\ 17.8\\ 36.9\\ 20.1\\ 17.8\\ 30.0\\ 13.7\\ 30.0\\ 12.8\\ 13.9\\ 12.8\\ 13.9\\ 13.$ 10890 9042 10824 6530 5302 6905 11068 12108 10103 9762 0 0948 0 0862 0 1184 0 0910 6133 6775 5162 6760 611.3248 615.0385 616.0413 617.0385 83846 30789 59593 0 0910 0 0879 0 0912 0 0893 6772 7019 6777 617 0365 618 0375 619 0355 620 0372 625 3851 641 3647 647 0659 648 0687 649 0611 650 0638 651 0578 655 3564 669 4128 24087 38759 12660 11209 6932 6539 6170 6444 0 0948 0 1014 0 0995 0 0930 0 0950 0 0951 0 0903 0 1042 0 1299 0 0968 0 1112 0 1069 9758 24443 8667 18458 6954 6824 6824 7198 6251 8126 11817 8730 5045 6773 6166 28 29 30 669 4128 685 4024 713 4370 10391 9668 8601 18.8 15.7 14.1 6673

Mass Spectrum List Report



Bruker Daltonics DataAnalysis 3.3

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Figure A-35: HR-ESI-mass spectrum of compound 14c

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APPENDIX B



Figure B-1: Absorption spectrum of compound 1 in toluene



Figure B-2: Calibration curve for determining a molar absorptivity of compound 1 in toluene (λ_{abs} = 503 nm)



Figure B-3: Emission spectrum of compound 1 in toluene (λ_{ex} = 470 nm)



Figure B-4: Relationship between absorbance and integrated intensity of compound 1 in toluene



Figure B-5: Absorption spectrum of compound 2 in toluene



Figure B-6: Calibration curve for determining a molar absorptivity of compound 2 $\mbox{in toluene}~(\lambda_{abs}=514~\mbox{nm})$



Figure B-7: Emission spectrum of compound 2 in toluene (λ_{ex} = 480 nm)



Figure B-8: Relationship between absorbance and integrated intensity of compound 2 in toluene



Figure B-9: Absorption spectrum of compound 3a in toluene



Figure B-10: Calibration curve for determining a molar absorptivity of compound 3a in toluene (λ_{abs} = 642 nm)







Figure B-12: Relationship between absorbance and integrated intensity

of compound **3a** in toluene



Figure B-13: Absorption spectrum of compound 3b in toluene



Figure B-14: Calibration cure for determining a molar absorptivity of compound 3b in toluene (λ_{abs} = 656 nm)



Figure B-15: Emission spectrum of compound 3b in toluene ($\lambda_{\rm ex}$ = 600 nm)



Figure B-16: Relationship between absorbance and integrated intensity of compound 3b in toluene



Figure B-17: Absorption spectrum of compound 3c in toluene



Figure B-18: Calibration curve for determining a molar absorptivity of compound 3c

in toluene (λ_{abs} = 658 nm)



Figure B-19: Emission spectrum of compound 3c in toluene (λ_{ex} = 600 nm)



Figure B-20: Relationship between absorbance and integrated intensity of compound **3c** in toluene



Figure B-21: Absorption spectrum of compound 4b in toluene



Figure B-22: Calibration curve for determining a molar absorptivity of compound 4b in toluene (λ_{abs} = 556 nm)



Figure B-23: Emission spectrum of compound 4b in toluene (λ_{ex} = 500 nm)



Figure B-24: Relationship between absorbance and integrated intensity of compound 4b in toluene



Figure B-25: Absorption spectrum of compound 13a in toluene



Figure B-26: Calibration curve for determining a molar absorptivity of compound 13a in toluene (λ_{abs} = 289 nm)



Figure B-27: Absorption spectrum of compound 13b in toluene



Figure B-28: Calibration cure for determining a molar absorptivity of compound 13b in toluene (λ_{abs} = 288 nm)



Figure B-29: Absorption spectrum of compound 13c in toluene



Figure B-30: Calibration curve for determining a molar absorptivity of compound 13c in toluene (λ_{abs} = 289 nm)



Figure B-31: Absorption spectrum of compound 14a in toluene



Figure B-32: Calibration cure for determining a molar absorptivity of compound 14a in toluene (λ_{abs} = 574 nm)



Figure B-33: Absorption spectrum of compound 14b in toluene



Figure B-34: Calibration curve for determining a molar absorptivity of compound 14b in toluene (λ_{abs} = 579 nm)



Figure B-35: Absorption spectrum of compound 14c in toluene



Figure B-36: Calibration curve for determining a molar absorptivity of compound 14c in toluene (λ_{abs} = 589 nm)

VITA

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Miss Jittikarn Songkhao was born on October 27, 1988 in Samutprakarn Province, Thailand. She got a Bachelor's Degree of Chemistry in Faculty of Science at Silpakom University, Nakom Pathom in 2010. After that, she was admitted into a Master Degree program in Petrochemistry and Polymer Science, Faculty of Science, Chulalongkorn University, Bangkok in 2010. She had presented her research on "Synthesis of BODIPY-thiophene conjugate for optoelectronics for applications" in 39th Congress on Science and Technology of Thailand by poster presentations and completed the program in 2013.



