

Electronic supplementary information

SYNTHESIS AND PROPERTIES OF NOVEL ARYLAMINE DERIVATIVES OF BENZOTHIENO[3,2-b][1]BENZOTHIOPHENE

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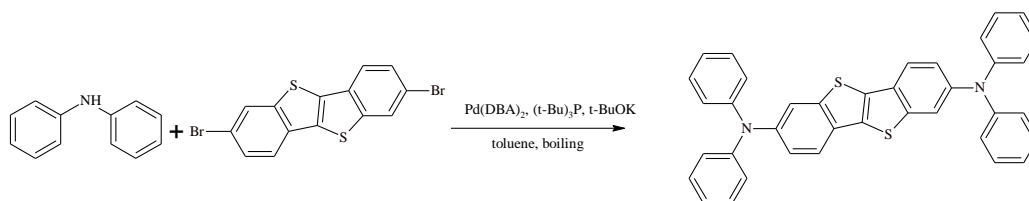
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Table of contents

Syntheses	S2
Procedures for the synthesis of (DPA) ₂ BTBT	S2
Procedures for the synthesis of (NPA) ₂ BTBT	S2
Procedures for the synthesis of (NTPDA) ₂ BTBT	S3
NMR spectra for the synthesized compounds	S5
¹ H NMR spectrum of (DPA) ₂ BTBT	S5
¹ H NMR spectrum of (NPA) ₂ BTBT	S5
¹ H NMR spectrum of <i>N'</i> -1-naphthyl- <i>N,N</i> -diphenylbenzene-1,4-diamine	S6
¹ H NMR spectrum of (NTPDA) ₂ BTBT	S6
GPC for the synthesized compounds	S7
GPC of (DPA) ₂ BTBT	S7
GPC of (NPA) ₂ BTBT	S8
GPC of (NTPDA) ₂ BTBT	S9
DSC for the synthesized compounds	S10
DSC of (DPA) ₂ BTBT	S10
DSC of (NPA) ₂ BTBT	S10
DSC of (NTPDA) ₂ BTBT	S11
TGA of (DPA) ₂ BTBT, (NPA) ₂ BTBT, (NTPDA) ₂ BTBT	S12
Optical properties	S13
References	S15

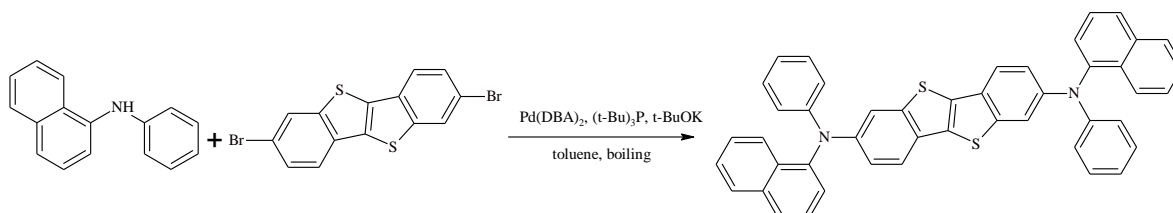
Syntheses

Procedures for the synthesis of (DPA)₂BTBT



This method was based on the literature procedure [1]. 29 mg (0.00005 mol) of Pd(dba)₂ and 50 mg (0.00025) of *t*-Bu₃P were added to a stirred solution of 1.2751 g (0.00754 mol) of *N*-phenylaniline [1], 0.5626 g (0.00502 mol) of potassium *tert*-butoxide, and 1 g (0.00251 mol) of BTBT-Br₂ [2] in anhydrous toluene (50 mL) at 100 °C (oil bath temperature 115 °C) under an argon atmosphere for 15 h. Toluene was removed under reduced pressure. The product was isolated by passing the resulting mixture through a layer of silica gel in toluene. The crude product was purified by recrystallization from toluene to give the target product as a yellow powder (1.3 g, 92%). ¹H NMR (250 MHz, benzene-d): 7.00–7.08 (m, 4H, Ph), 7.10–7.19 (t, 12H, Ph, *J* = 7.9 Hz), 7.20–7.23 (m, 2H, BTBT), 7.27–7.39 (d, 4H, Ph, *J* = 8.2 Hz), 7.52–7.55 (d, 2H, BTBT, *J* = 1.8 Hz), 7.62–7.70 (d, 2H, BTBT, *J* = 8.5 Hz). Anal. Calcd. for C₃₈H₂₆N₂S₂: C, 79.41; H, 4.56; N, 4.87; S, 11.16. Found: C, 79.76; H, 4.51; N, 4.90; S, 11.21%. MS-MALDI (*m/z*): [*M*]⁺ calcd for (C₃₈H₂₆N₂S₂) 574.1532, found 574.1517.

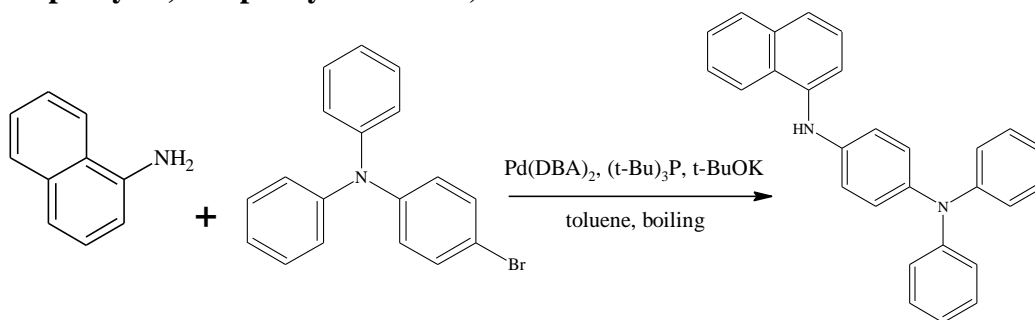
Procedures for the synthesis of (NPA)₂BTBT



29 mg (0.00005 mol) of Pd(dba)₂ and 50 mg (0.00025) of *t*-Bu₃P were added to a stirred solution of 1.6523 g (0.00754 mol) of *N*-phenyl-1-naphthalenamine [3], 0.5626 g (0.00502 mol) of potassium *tert*-butoxide and 1 g (0.00251 mol) of BTBT-Br₂ [2] in anhydrous toluene (50 mL) at 100 °C (oil bath temperature 115 °C) under an argon atmosphere for 7 h. Toluene was removed under reduced pressure. The product was isolated by passing the resulting mixture through a layer of silica gel in toluene. The crude product was purified by column chromatography (eluent: toluene/cyclohexane, 1:3) to give the target compound as a yellow powder (1.1 g, 63%). ¹H NMR (250 MHz, benzene-d): 6.74–6.84 (m, 2H, Ph), 6.94–6.99 (m, 10 H, Napht), 7.02–7.05 (m, 4H, Napht), 7.07–7.15 (m, 4H, BTBT), 7.16–7.21 (d, 2H, Ph, *J* = 8.5 Hz), 7.48–7.55 (m, 4H, Ph), 7.59–7.66 (d, 2H, Ph, *J* = 8.5 Hz), 8.09–8.16 (d, 2H, BTBT, *J* = 8.2 Hz). Anal. Calcd. for C₄₆H₃₀N₂S₂: C, 81.87; H, 4.48; N, 4.15; S, 9.50. Found: C, 81.74; H, 4.49; N, 4.13; S, 9.61%. MS-MALDI (*m/z*): [*M*]⁺ calcd for (C₄₆H₃₀N₂S₂) 674.1845, found 674.1837.

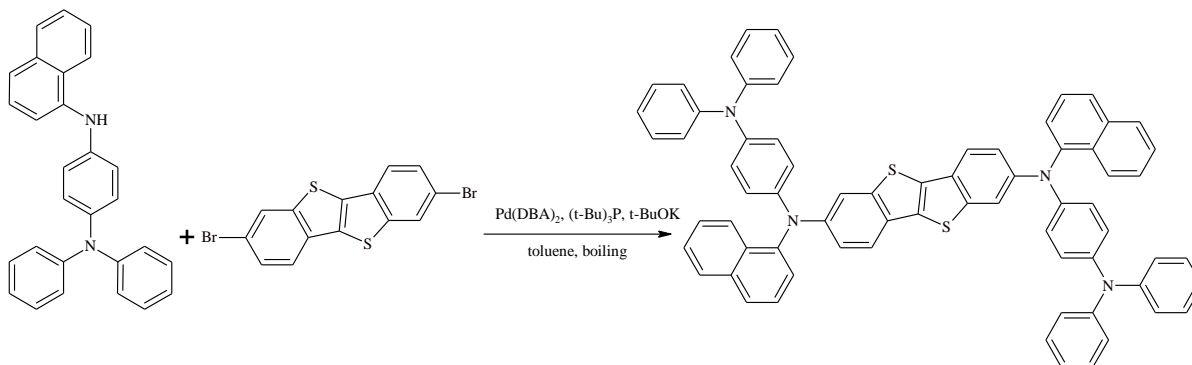
Procedures for the synthesis of (NTPDA)₂BTBT

N'-1-Naphthyl-*N,N*-diphenylbenzene-1,4-diamine



The synthesis was carried out according to the published procedure [4]. 308 mg (0.0005 mol) of Pd(dba)₂ and 217 mg (0.001 mol) of t-Bu₃P was added to a stirred solution of 17.4 g (0.054 mol) of 4-bromo-*N,N*-diphenylaniline [5], 6 g (0.054 mol) of potassium *tert*-butoxide and 23 g (0.16 mol) of 1-naphthylamine in anhydrous toluene (500 mL) at 100 °C (oil bath temperature 115 °C) under an argon atmosphere for 6 h. Toluene was removed under reduced pressure. The product was isolated by passing the reaction mixture through a layer of silica gel in toluene. The crude product was purified by column chromatography (eluent: toluene/cyclohexane, 1:3) to give pure compound as a yellow powder (12.4 g, 60%). ¹H NMR (250 MHz, benzene-d): 7.82–7.76 (m, 1H, Ph), 7.70–7.63 (m, 1H, Ph), 7.38–7.44 (dd, 1H, Ph, *J* = 7.3, 1.8 Hz), 7.35–7.27 (ddd, 1H, Ph, *J* = 8.2, 6.8, 1.5 Hz), 7.26–7.15 (m, 7H, Napht), 7.13–7.04 (m, 4H, Ph), 7.01–6.95 (m, 2H, Ph), 6.89–6.76 (m, 2H, Ph), 6.71–6.58 (m, 2H, Ph), 5.29 (s, 1H, NH).

(NTPDA)₂BTBT



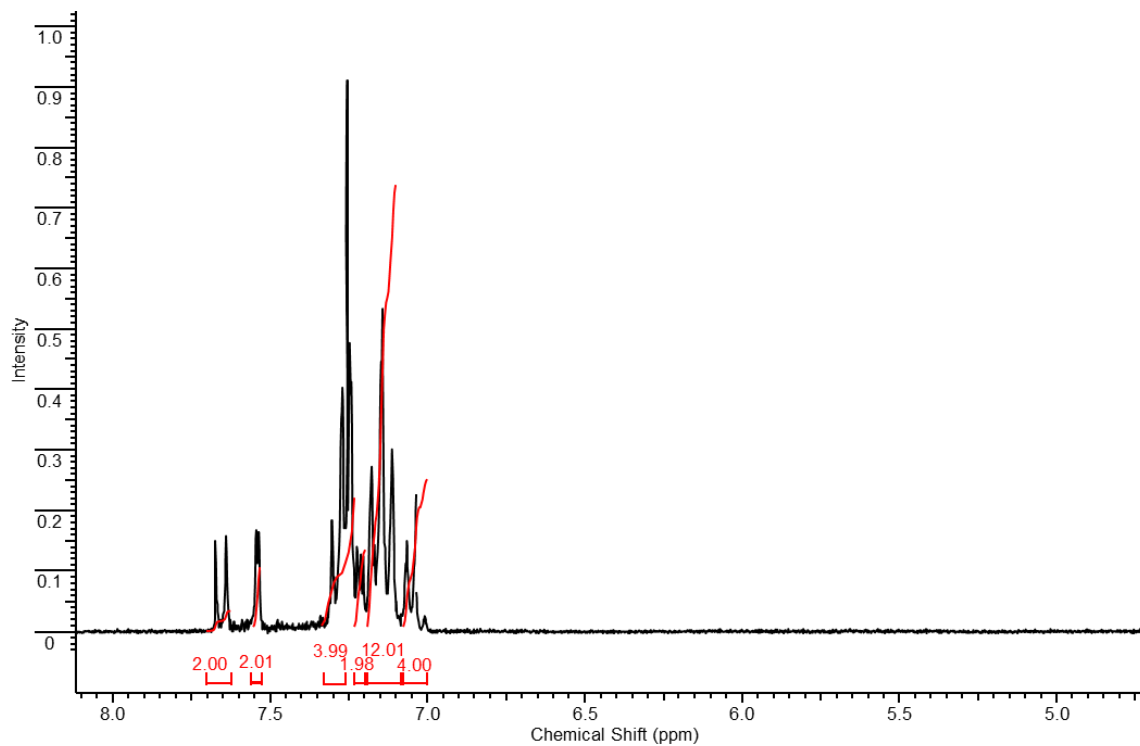
29 mg (0.00005 mol) of Pd(dba)₂ and 50 mg (0.00025) of t-Bu₃P was added to a stirred solution of 2.9123 g (0.00754 mol) of *N'*-1-naphthyl-*N,N*-diphenylbenzene-1,4-diamine, 0.5626 g (0.00502 mol) of potassium *tert*-butoxide and 1 g (0.00251 mol) of BTBT-Br₂ [2] in anhydrous toluene (50 mL) at 100 °C (oil bath temperature 115 °C) under an argon atmosphere for 7 h. Toluene was removed under reduced pressure. The product was separated by passing the reaction mixture through a layer of silica gel in toluene. The crude product was purified by column chromatography (toluene/cyclohexane, 1:3) to give the target compound as a yellow powder (1.4 g, 54%). ¹H NMR (250 MHz, benzene-d): 6.75–6.85 (t, 4H, Ph, *J* = 7.1 Hz), 6.88–6.95 (s, 8H, Ph), 6.97–7.07 (m, 8H,

Napht), 7.08–7.12(m, 16H, Ph), 7.18–7.28 (m, 6H, Napht), 7.48–7.56 (d, 4H, BTBT, $J = 11.6$ Hz), 7.60–7.66 (d, 2H, BTBT, $J = 9.2, 2.1$ Hz), 8.12–8.22 (dd, 2H, Napht, $J = 9.2, 2.1$ Hz). Anal. Calcd. for $C_{70}H_{48}N_4S_2$: C, 79.41; H, 4.56; N, 4.87; S, 11.16. Found: C, 79.50; H, 4.59; N, 4.84; S, 11.21%. MS-MALDI (m/z): $[M]^+$ calcd for ($C_{70}H_{48}N_4S_2$) 1008.3315, found 1008.3301.

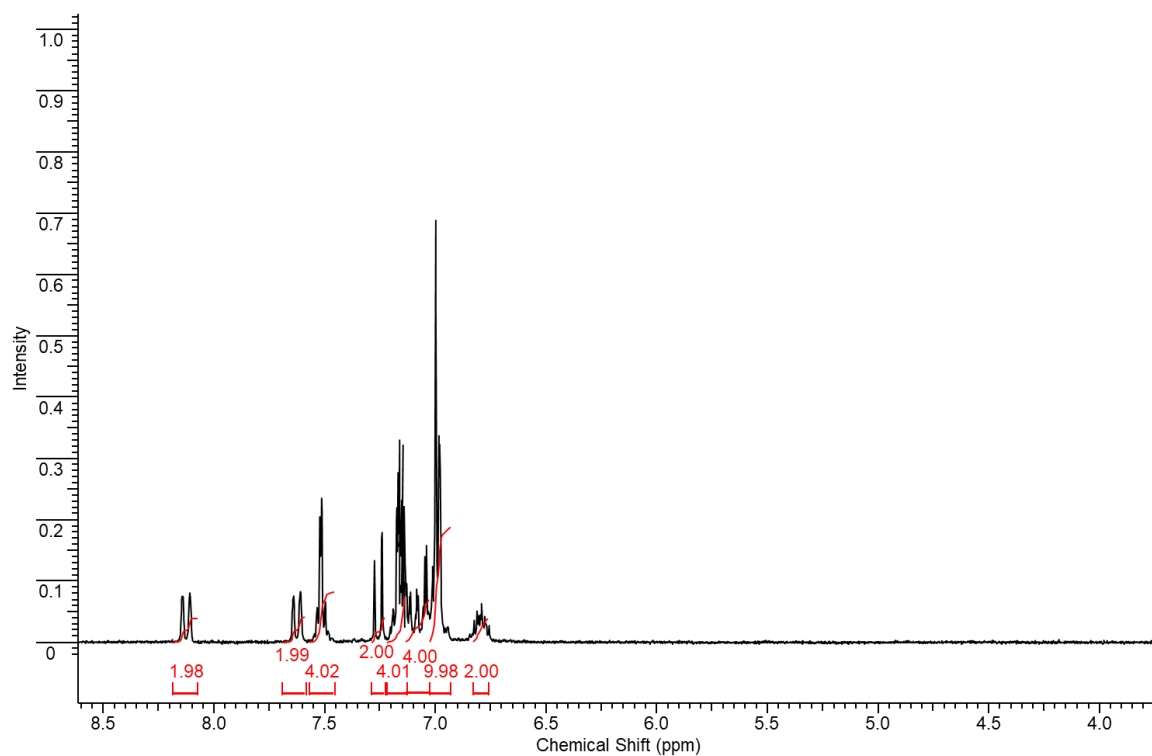
NMR spectra for the synthesized compounds

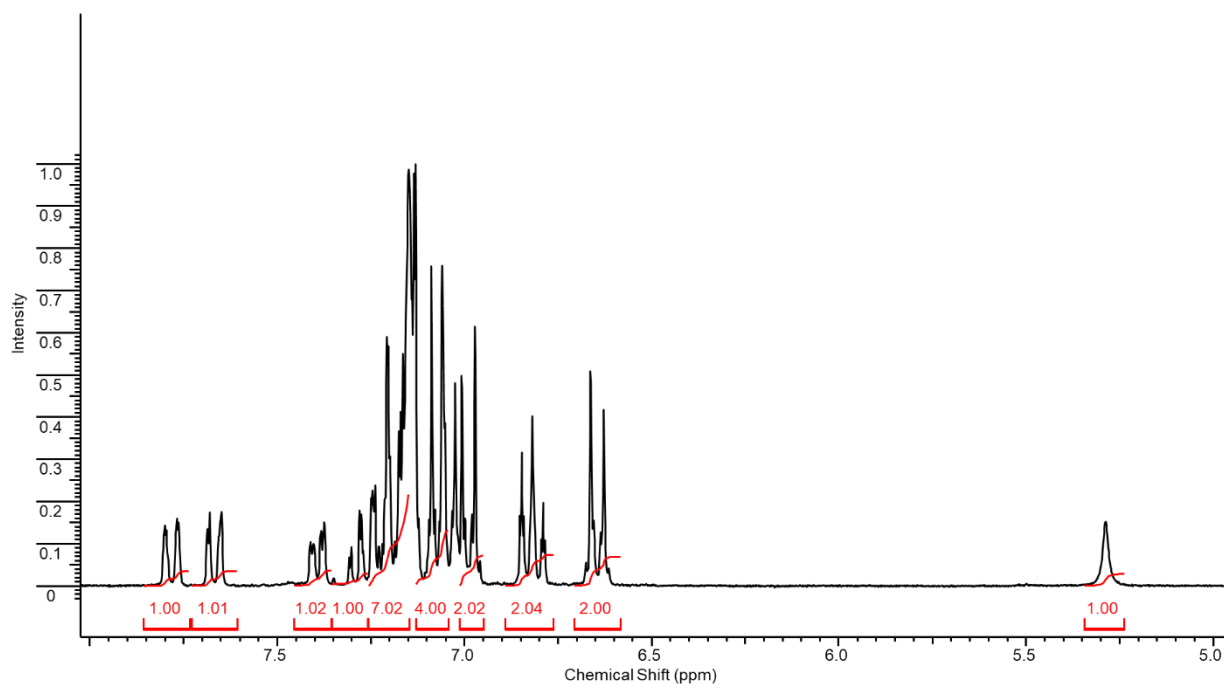
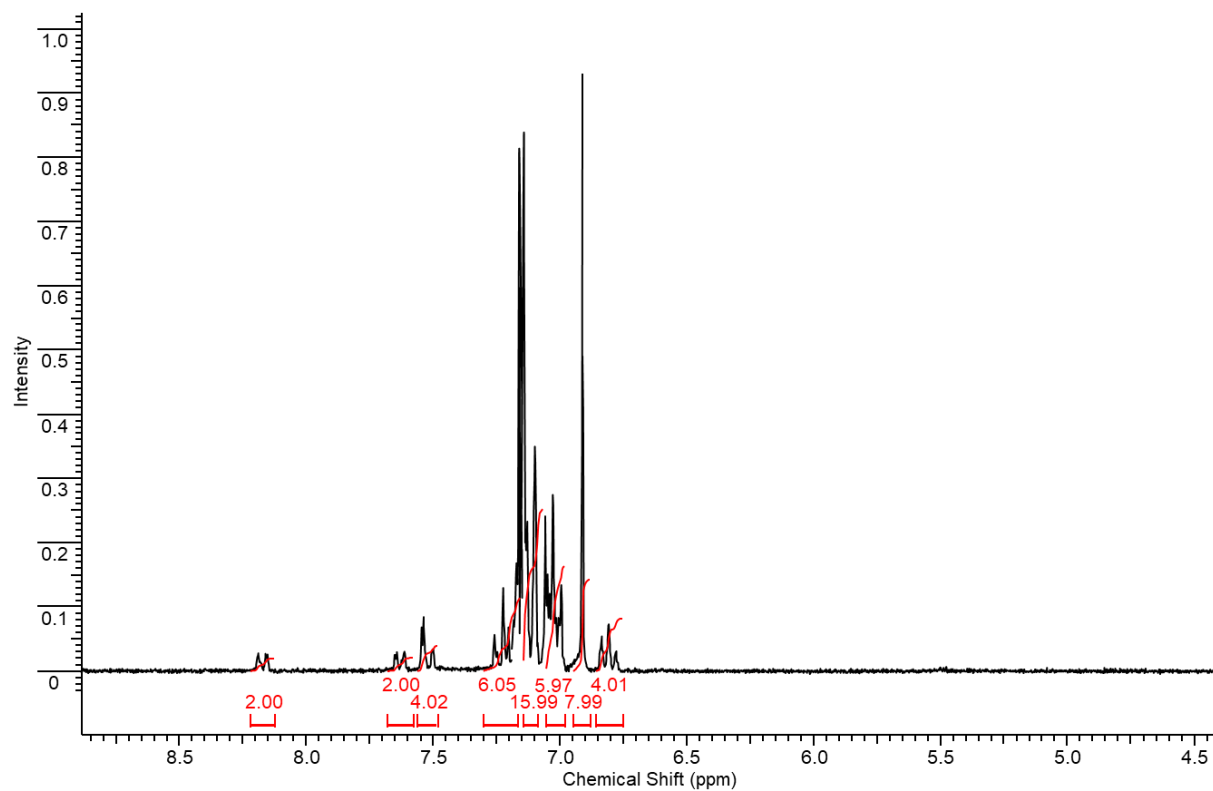
The ^1H NMR spectra were recorded on a Bruker WM-250 NMR spectrometer (Germany) at 250.13 MHz. The chemical shifts were referenced to the solvent signals.

^1H NMR spectrum of $(\text{DPA})_2\text{BTBT}$



^1H NMR spectrum of $(\text{NPA})_2\text{BTBT}$

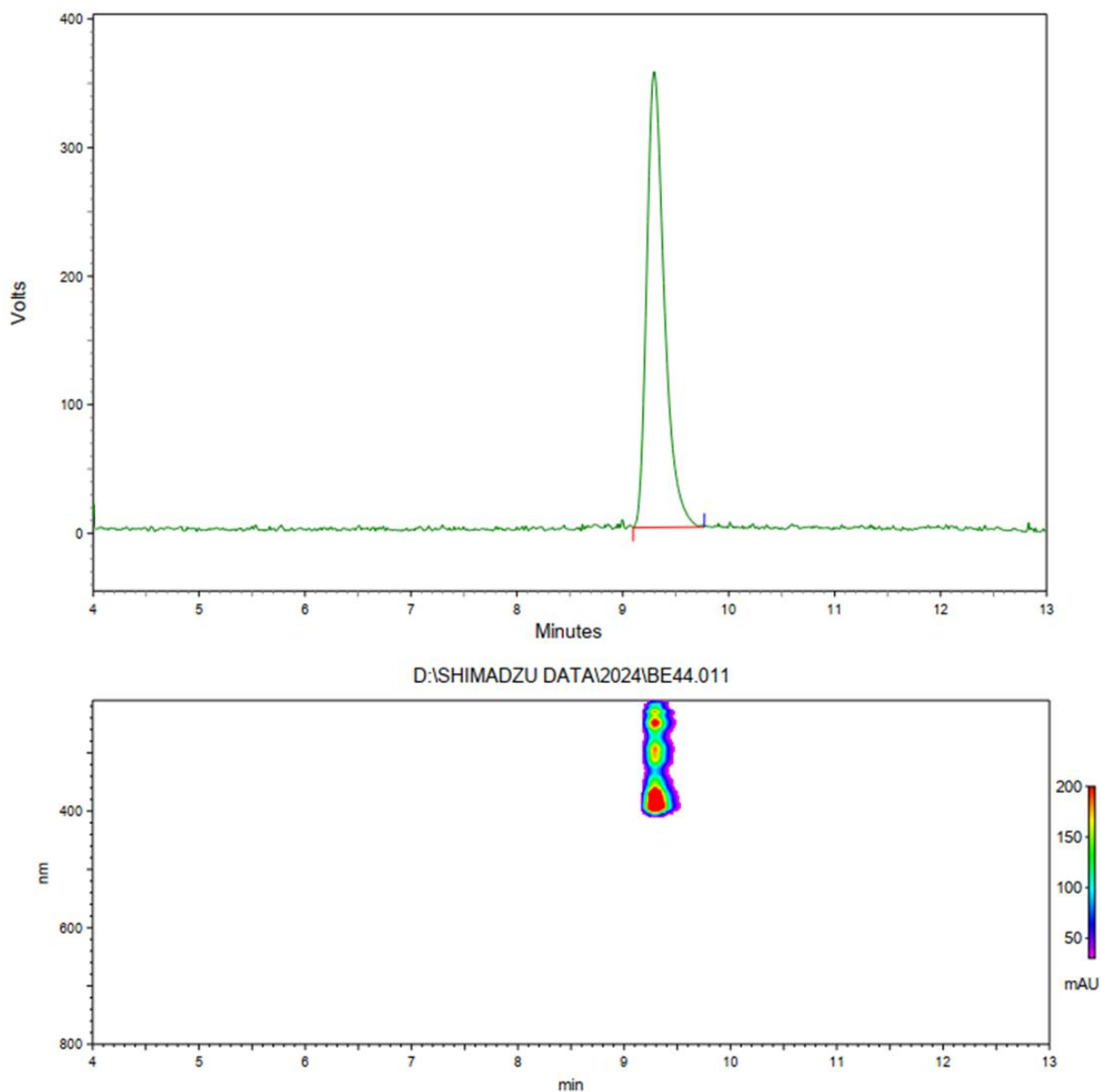


^1H NMR spectrum of *N'*-1-naphthyl-*N,N*-diphenylbenzene-1,4-diamine **^1H NMR spectrum of (NTPDA)₂BTBT**

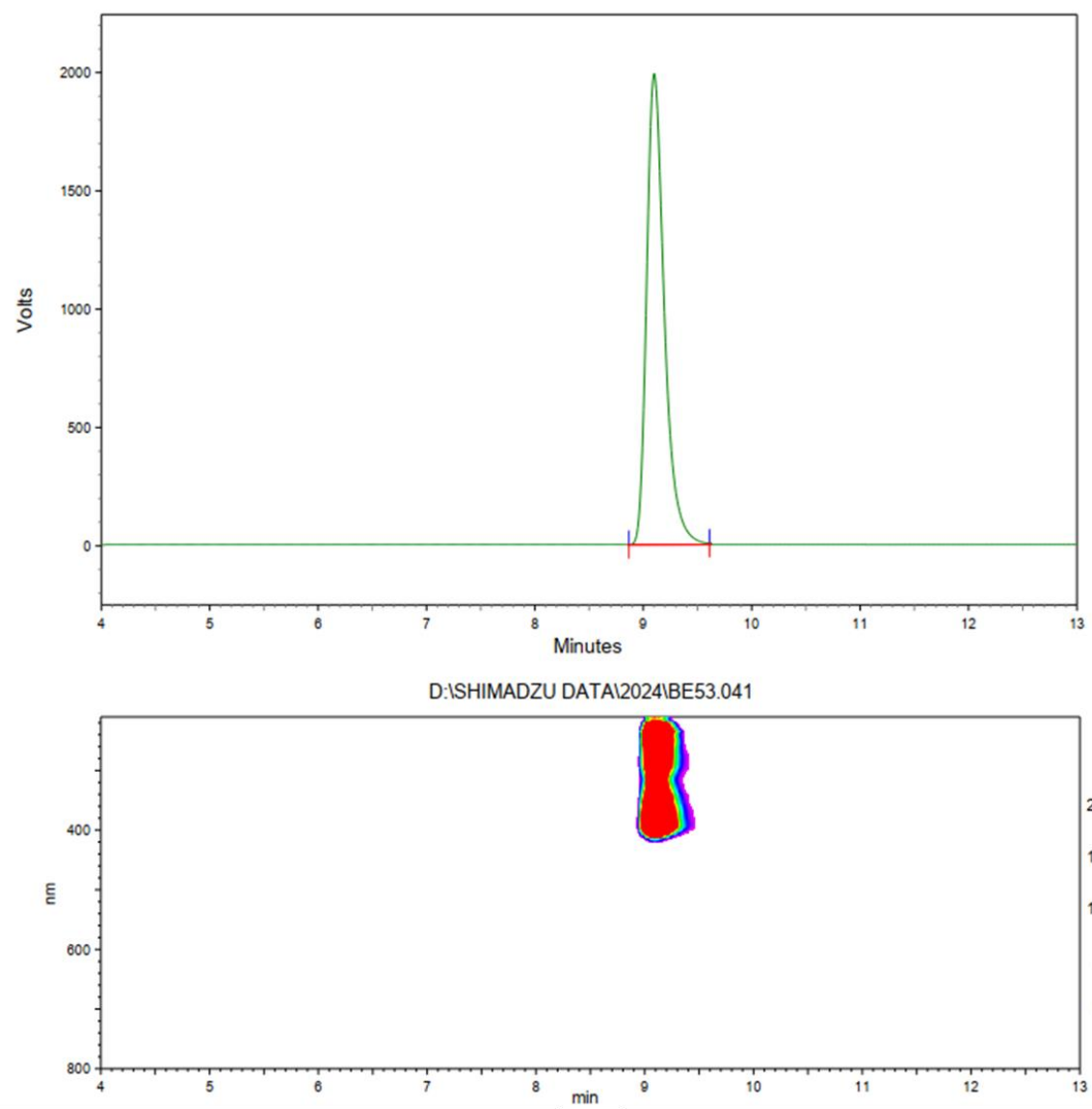
GPC for the synthesized compounds

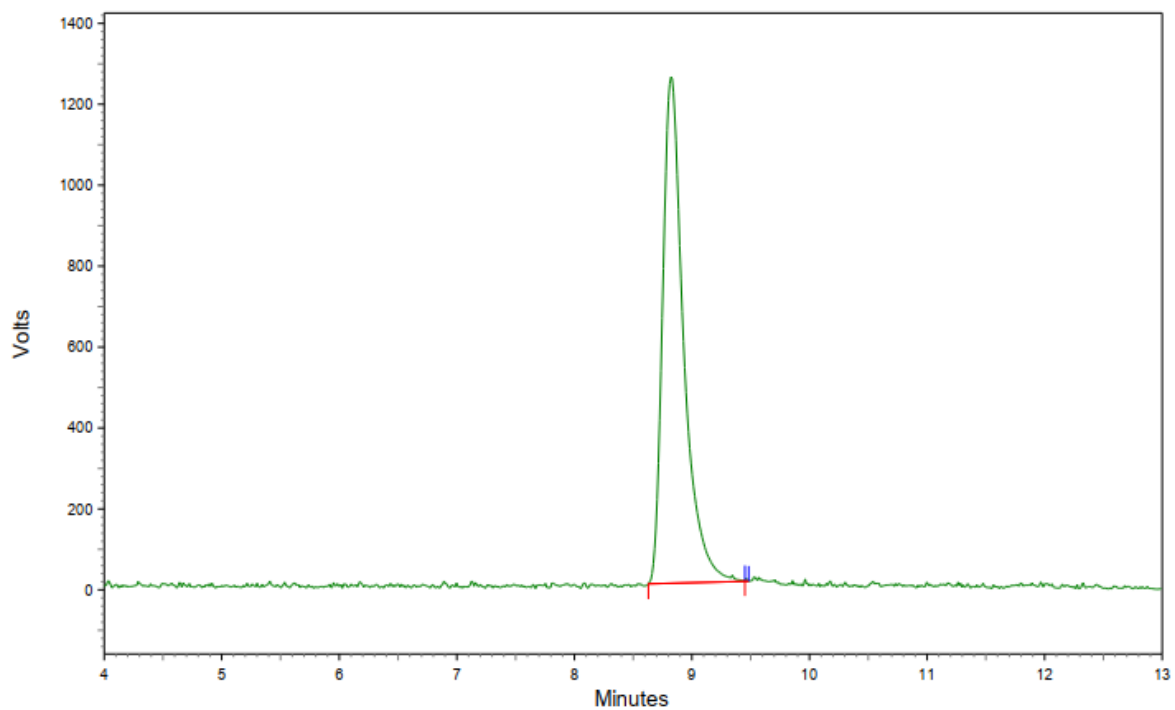
The GPC analysis was performed on a Shimadzu instrument equipped with a RID10AVP refractometer and an SPD-M10AVP diode matrix as detectors using $7.8 \times 300 \text{ mm}^2$ Phenomenex columns (USA) filled with Phenogel sorbent with the pore size of 500 \AA and THF as an eluent.

GPC of (DPA)2BTBT

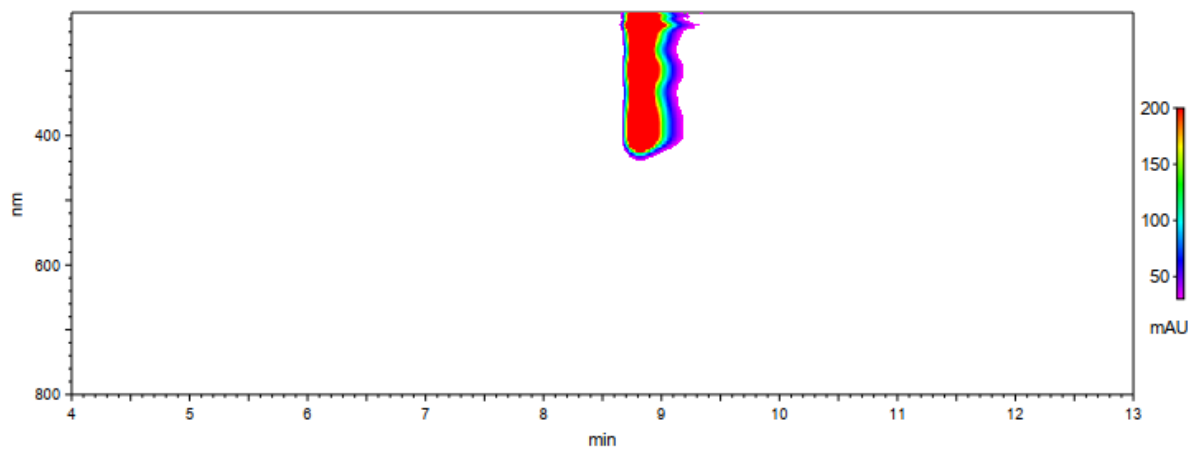


GPC of (NPA)2BTBT



GPC of (NTPDA)2BTBT

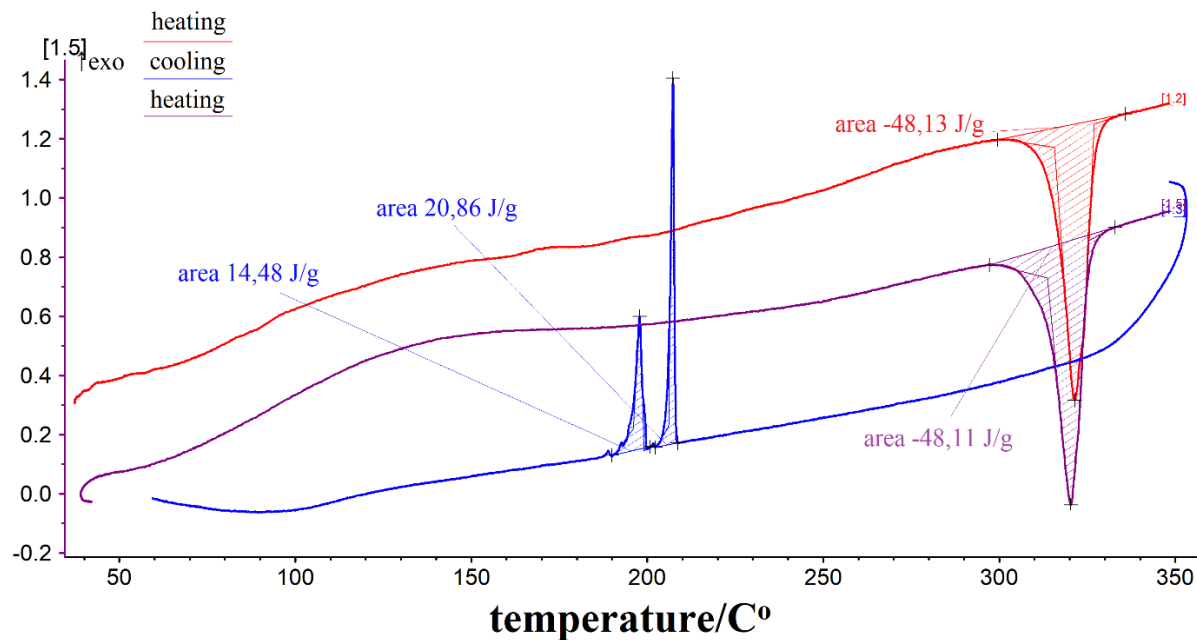
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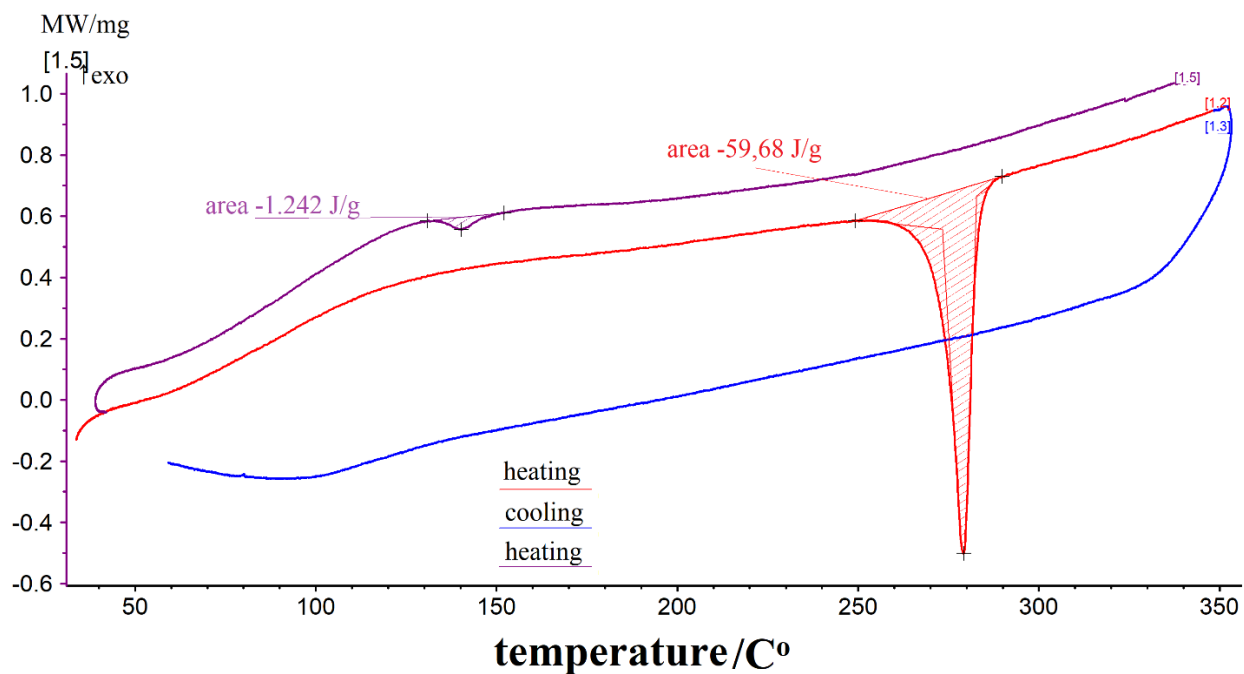
DSC for the synthesized compounds

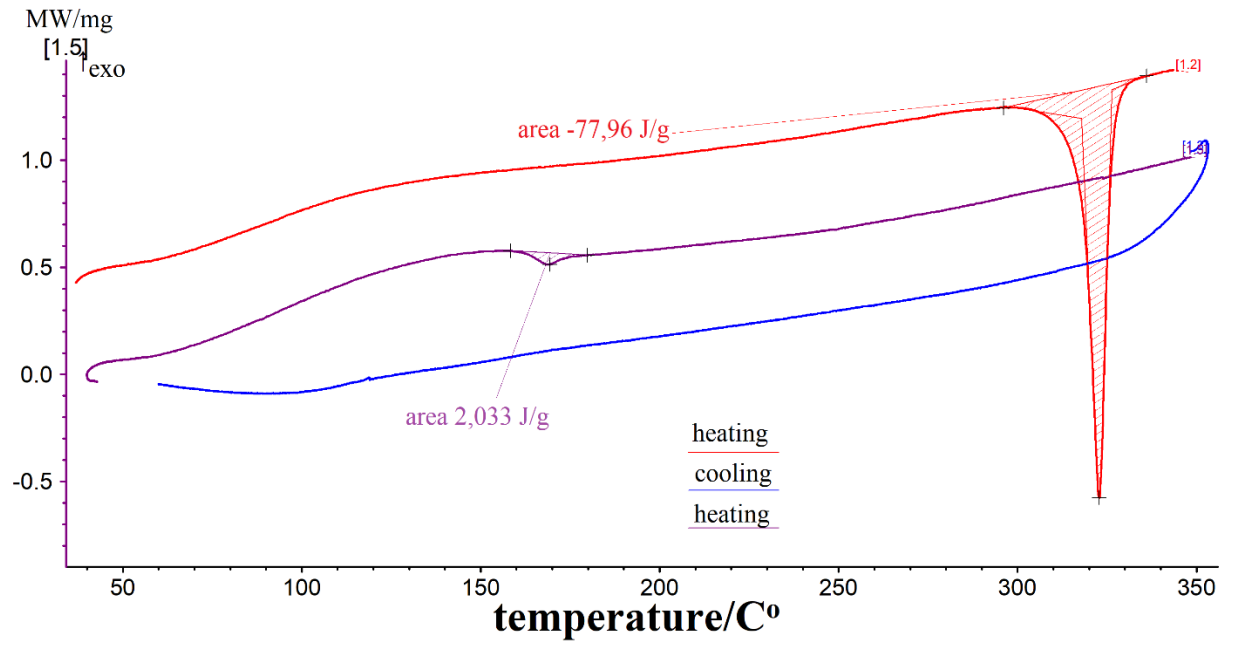
The DSC curves were recorded on a Perkin-Elmer DSC7 differential scanning calorimeter (Germany) in the temperature range from 40 to 350 °C under an argon atmosphere.

DSC of (DPA)₂BTBT



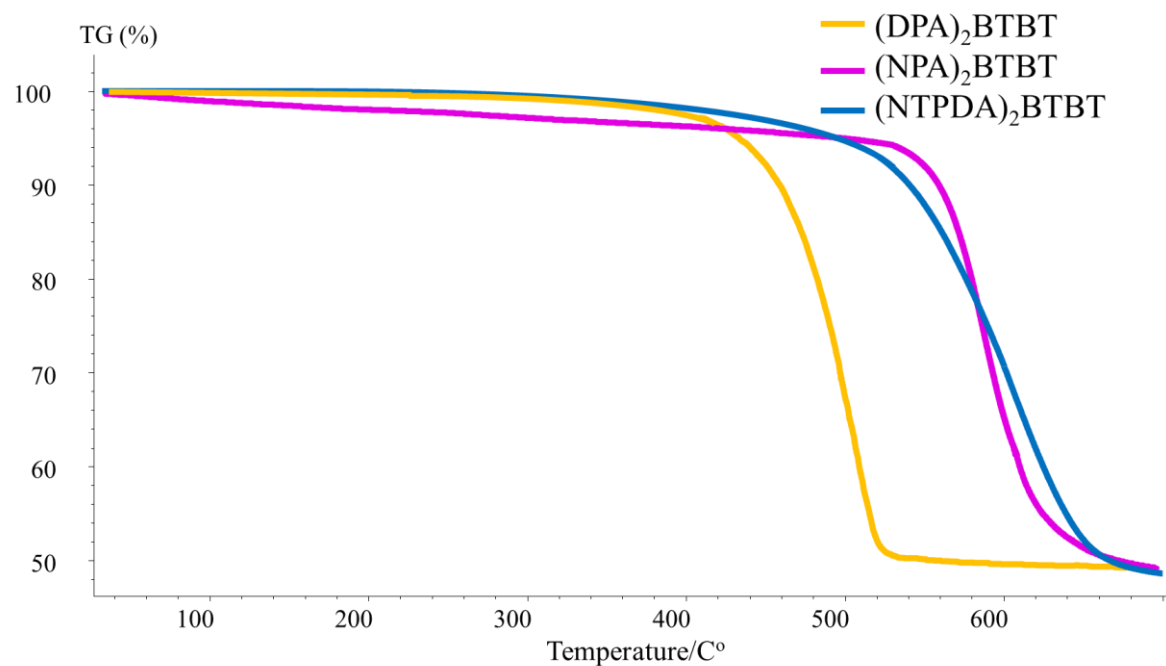
DSC of (NPA)₂BTBT



DSC of (NTPDA)₂BTBT

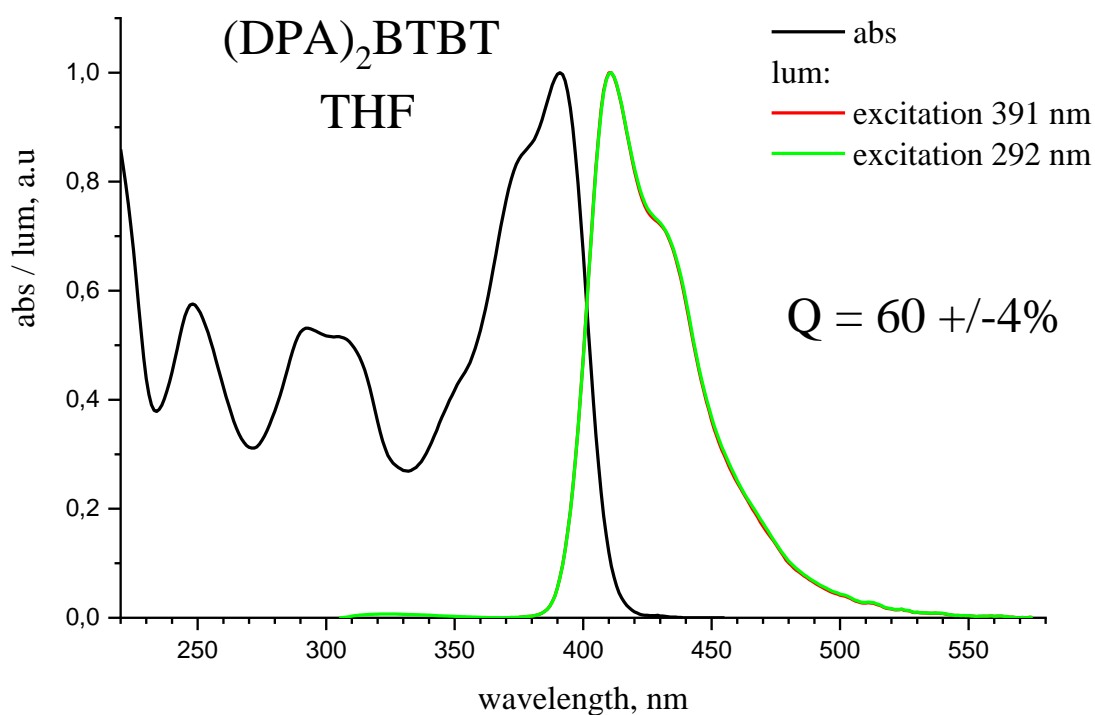
TGA of (DPA)₂BTBT, (NPA)₂BTBT, and (NTPDA)₂BTBT

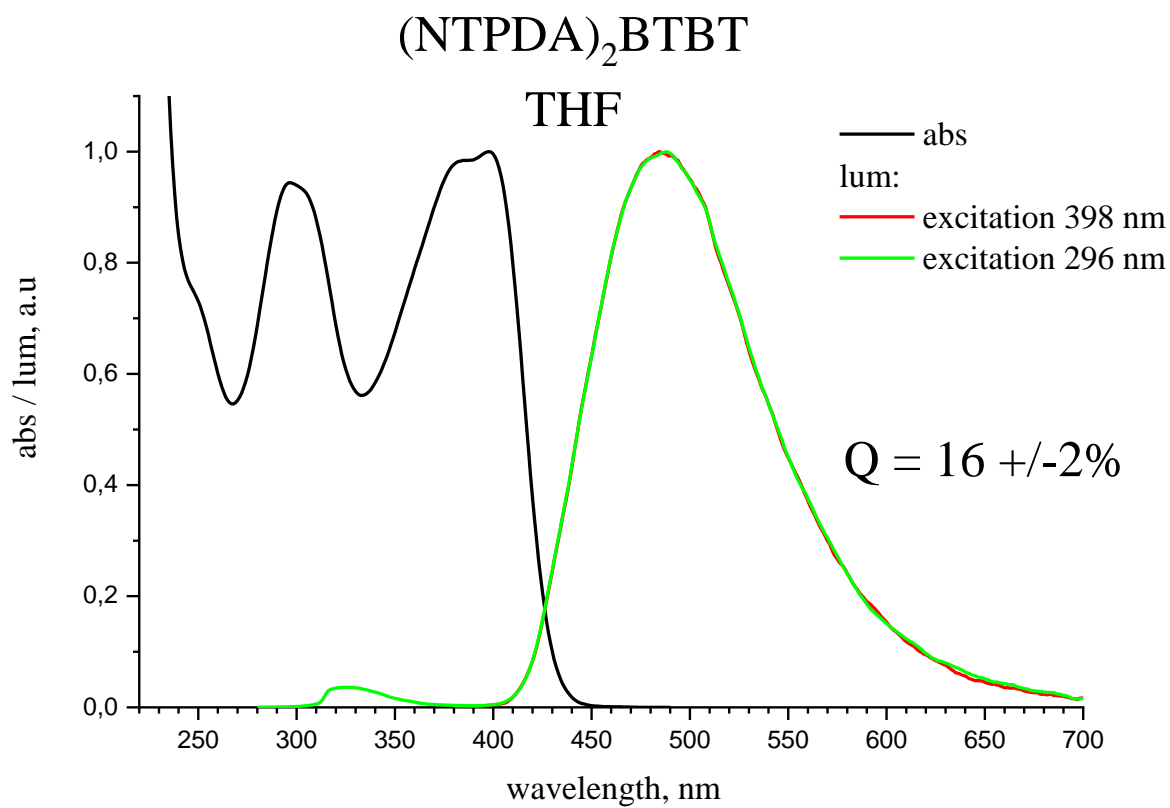
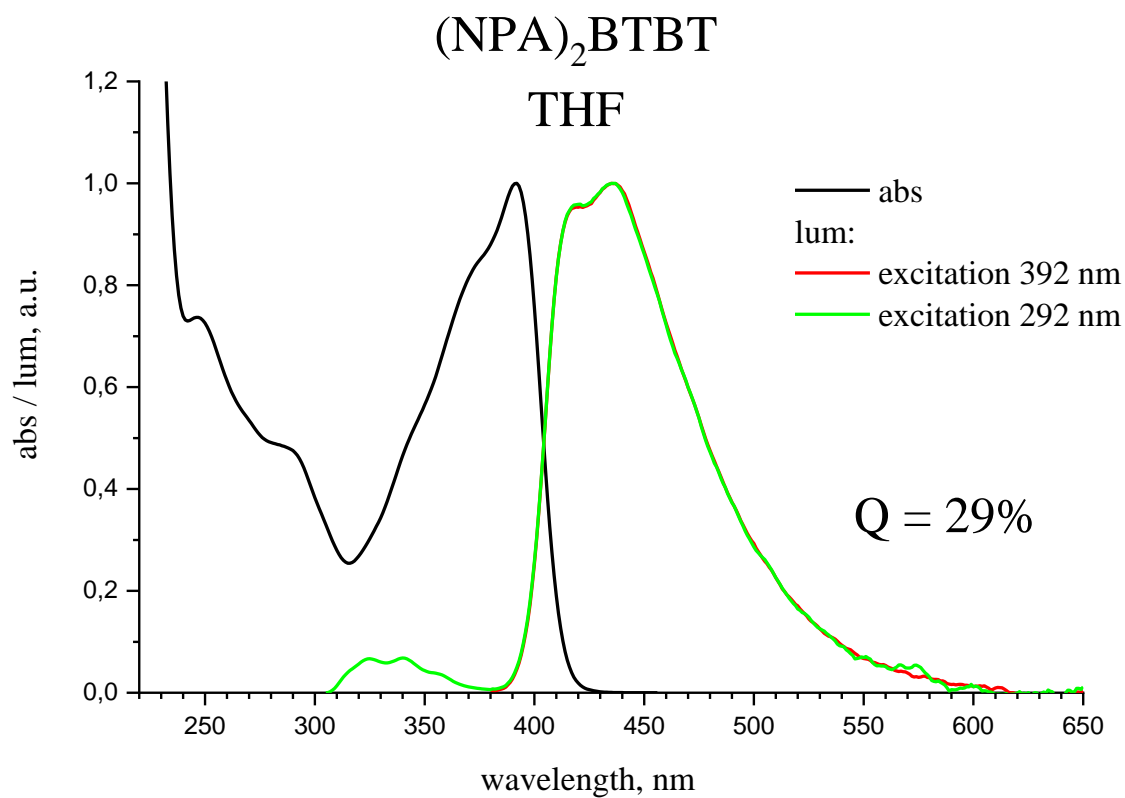
The TGA curves were recorded on a NETZSCH STA JUPITER 443 F3 instrument (Germany) in the temperature range from 40 to 700 °C.



Optical properties

The absorption spectra of THF solutions of the compounds explored were measured with a Shimadzu UV-2501PC spectrophotometer (Japan). The standard 10×10 quartz cuvettes were used to measure the luminescence spectra of the solutions. The quantum yields were determined relative to the known quantum yields of the standards used for measuring the fluorescence of optically dilute solutions. A solution of *p*-terphenyl in cyclohexane ($\phi = 0.91$) was used as a standard for measuring the quantum yields.





References

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5. S. Nad, S. Malik, *ChemElectroChem*, **2020**, *7*, 4144–4152. DOI: 10.1002/celec.202001114