Asymmetric Molecules in the Polymorph of 2-Amino-4,5,6,7-tetrahydrobenzo-[b]thiophene-3-carbonitrile

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The title compound, 2-amino-4,5,6,7-tetrahydrobenzo[b]thiophene-3-carbonitrile, $C_9H_{10}N_2S$, crystallizes in the monoclinic space group $P2_1/c$ with unit-cell parameters: $a = 13.3994(11)$, $b = 17.0170(16)$, $c = 7.9319(8)$ Å, $\beta = 90.051(9)^\circ$, $Z = 8$. The asymmetric unit of the title compound, $C_9H_{10}N_2S$, contains two crystallographically independent molecules, A and B; the cyclohexene rings in both molecules exhibits the half-chair conformation. The packing of the molecules is stabilized by a few N-H...N interactions, which are arranged in such a manner as to form chains.

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Thiophene moieties containing heterocyclic compounds are well-known for their wide range of biological activities, such as anti-diabetic,¹ anti-inflammatory,² anti-bacterial, anti-depressant³ and anti-allergic.⁴ These are of great importance for the preparation of various pharmaceuticals, and are also used for treating a number of fatal diseases, like cancer and gastric ulcers.⁵ The title compound, $C_9H_{10}N_2S$, was synthesized by preparing a mixture of maleonitrile (NCCH₂CN, 6.6 g, 0.1 mol), sulphur (3.2 g, 0.1 mol) and ethanol (50 ml). The obtained mixture was stirred at 45 – 50°C. Once the temperature was obtained, Diethylamine (10 ml) was added dropwise until sulphur completely dissolved. The obtained solid was filtered, washed with ethanol and recrystallized from the benzene. (Yield, 95.75%; M.P, 92°C). The chemical structure of the title compound is shown in Fig. 1.

X-ray intensity data, for a crystal having dimensions 0.30 × 0.20 × 0.20 mm, consisting of 4650 reflections (of which 2965 unique), were collected at 293(2)K on a X'calibur CCD area-detector diffractometer equipped with graphite monochromated Mo K_α radiation ($\lambda = 0.71073$ Å). The intensities were measured by the ω scan mode for θ ranges of 3.83 to 26.00°; 2024 reflections were treated as observed ($I > 2\sigma(I)$). Data were corrected for Lorentz and polarization factors. The structure was solved by direct methods using SHELXS97.⁶ All non-hydrogen atoms of the molecule were located in a best E-map.

Fig. 1 Chemical structure of the 2-Amino-4,5,6,7-tetrahydrobenzo[b]thiophene-3-carbonitrile.

A full-matrix least-squares refinement was carried out using SHELXL97.⁶ All hydrogen atoms (except for N1 hydrogen atoms for molecules A and B) were geometrically fixed and allowed to ride on the corresponding non-H atoms with C-H = 0.97 Å, and 1.2 U_{eq} for H atoms. The final refinement cycle converged to $R = 0.0591$ and $wR(F^2) = 0.1341$ for the observed 2024 reflections. The residual electron densities ranged from –0.326 to 0.427 $e\text{Å}^{-3}$. Atomic scattering factors were taken from International Tables for X-ray Crystallography (1992, Vol. C, Tables 4.2.6.8 and 6.1.1.4). The crystallographic data are summarized in Table 1. Selected bond lengths and bond angles

Table 1 Crystal and experimental data

Chemical formula: $C_9H_{10}N_2S$	
Formula weight: 178.25	
$T = 293$ K	
Crystal system: monoclinic	Space group: $P2_1/c$
$a = 13.3994(11)$ Å,	
$b = 17.0170(16)$ Å,	$\beta = 90.051(9)^\circ$,
$c = 7.9319(8)$ Å,	
$V = 1808.6(3)$ Å ³	$Z = 8$
$D_x = 1.309$ g/cm ³	D_m (floatation) = 1.305 g/cm ³
Radiation: Mo K_α ($\lambda = 0.71073$ Å)	
$\mu(\text{Mo } K_\alpha) = 0.099$ mm ⁻¹	$F(0\ 0\ 0) = 752$
Crystal size = 0.30 × 0.20 × 0.20 mm	
No. of reflections collected = 4650	
No. of independent reflections = 2965	
θ range for data collection: 3.83 to 26.00°	
Data/Restrains/parameter = 2965/0/233	
Goodness-of-fit on $F^2 = 1.042$	
R indices [$I > 2\sigma(I)$]: $R1 = 0.0591$, $wR2 = 0.1341$	
R indices (all data): $R1 = 0.0929$, $wR2 = 0.1584$	
$(\Delta/\sigma)_{\max} = 0.001$ for U22 C5B	
$(\Delta\rho)_{\max} = 0.427$ $e\text{Å}^{-3}$	$(\Delta\rho)_{\min} = -0.326$ $e\text{Å}^{-3}$
Measurement: X'calibur system-Oxford diffraction make, U.K.	
Programs system: SHELXL-97, CRYSLIS RED	
Structure determination: SHELXS-97	
CCDC deposition number: 974282	

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Table 2 Selected bond lengths (Å), and bond angles (°) for non hydrogen atoms in A & B molecules (e.s.d.'s are given in parentheses)

Bond lengths			
S1A - C1A	1.727(3)	S2B - C1B	1.726(3)
S1A - C8A	1.737(4)	S2B - C8B	1.739(4)
C9A - N2A	1.133(5)	C9B - N2B	1.146(4)
N1A - C1A	1.353(5)	C1B - N1B	1.351(5)
Bond angles			
C1A - S1A - C8A	92.4(2)	C1B - S2B - C8B	92.1(2)
N2A - C9A - C2A	178.6(5)	N2B - C9B - C2B	179.0(5)
N1A - C1A - C2A	128.8(3)	N1B - C1B - C2B	129.3(3)
N1A - C1A - S1A	121.1(3)	N1B - C1B - S2B	120.4(3)
C2A - C1A - S1A	110.1(3)	C2B - C1B - S2B	110.2(3)
C3A - C8A - S1A	111.6(3)	C7A - C8A - S1A	122.4(3)

Fig. 2 ORTEP⁷ view of the molecule with displacement ellipsoids drawn at 40%. H atoms are shown as small spheres of arbitrary radii.

are given in Table 2. An ORTEP⁷ view of the title compound with atomic labeling is shown in Fig. 2. The geometry of the molecule was calculated using the PLATON⁸ and PARST⁹ software.

The molecular and crystal structure of the title compound stands reported in the literature with the same crystal system, but with different unit-cell parameters.¹⁰ However, in the present investigation there exist two crystallographically independent molecules, A and B. Both molecules consist of a thiophene ring and a cyclohexene ring fused *via* atoms C3 and C8. The bond lengths and bond angles in both the molecules are normal,¹¹ and correspond to those observed in related structures.^{12,13} In both molecules, the thiophene ring makes a dihedral angle of 1.6(1)° and 2.6(1)°, respectively, with a cyclohexene ring. The thiophene ring (C2/C3/C8/S1/C1) is planar with maximum deviations of −0.005(4) Å for C8A and −0.003(4) Å for C8B in both molecules in the asymmetric unit. In both molecules, the cyclohexene ring adopts a *half chair* conformation with a two-fold symmetry element passing through the C3–C8 and C5–C6 bonds [asymmetric parameter being $\Delta C_2(C3A-C8A) = 4.37$ and $\Delta C_2(C3B-C8B) = 3.27$ for both molecules].¹⁴ The cyano group shows a linear character [(C2A–C9A–N2A) = 178.6(5)° and (C2B–C9B–N2B) = 179.0(5)°], a feature commonly observed in carbonitrile

Table 3 Hydrogen-bonding geometry (e.s.d.'s are given in parentheses)

D-H...A	D-H(Å)	H...A(Å)	D...A(Å)	D-H...A(°)
N1B-H1B...N2A	0.78(5)	2.36(5)	3.100(5)	160(4)
N1B-H2B...N2B ⁱ	0.91(4)	2.35(4)	3.177(5)	151(3)
N1A-H2A...N2B ⁱⁱ	0.84(4)	2.31(4)	3.105(5)	160(4)
N1A-H1A...N2A ⁱⁱⁱ	0.89(4)	2.46(4)	3.221(5)	143(3)

Symmetry code: (i) $-x-1, -y, -z+1$ (ii) $x+1, +y, +z$ (iii) $-x-1, -y, -z+1$

compounds.¹⁰

A packing view of the molecules in the unit cell viewed down the *c*-axis is shown in Fig. 3S. Strong N-H...N intramolecular interactions are responsible for the stability of molecules within the unit cell. The crystal packing is further stabilized by the existence of three strong intermolecular N-H...N interactions. These interactions link the molecules and generate a chain-like structure that runs parallel along the *c*-axis (Fig. 3S). A summary of the intra- and intermolecular hydrogen bonds is given in Table 3.

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References

1. Y. N. Mabkhot, A. Barakat, A. M. Al-Majid, Z. A. Al-Othman, and A. S. Alamary, *Int. J. Mol. Sci.*, **2011**, *12*, 7824.
2. R. Mishra, I. Tomar, S. Singhal, and K. K. Jha, *Pharma Chem.*, **2011**, *3*, 38.
3. Y. N. Mabkhot, A. Barakat, and S. J. Alshahrani., *Mol. Struct.*, **2012**, *1027*, 15.
4. Y. N. Mabkhot, A. Barakat, A. M. Al-Majid, and S. A. Alshahrani., *Int. J. Mol. Sci.*, **2012**, *13*, 2263.
5. A. Bishayee, R. Karmaker, A. Mandal, S. N. Kundu, and M. Chatterjee, *Eur. J. Cancer Prev.*, **1997**, *6*, 58.
6. G. M. Sheldrick, *Acta Cryst.*, **2008**, *A64*, 112.
7. L. J. Farrugia, *J. Appl. Cryst.*, **1999**, *32*, 837.
8. A. L. Spek, *Acta Cryst.*, **2009**, *D65*, 148.
9. M. Nardelli, *J. Appl. Cryst.*, **1995**, *28*, 659.
10. W. L. Silva, M. do C. A. de Lima, S. L. Galdino, I. R. Pitta and C. A. De Simone, *Acta Cryst.*, **2011**, *E67*, o3161.
11. F. H. Allen, O. Kennard, D. G. Watson, L. Brammer, A. G. Orpen, and R. Taylor, *J. Chem. Soc., Perkin Trans-II*, **1987**, S1.
12. H. Nerenz, W. Grahn, and P. G. Jones, *Acta Cryst.*, **1997**, *C53*, 787.
13. H. Cheng, B. Djukic, E. L. Harrington, F. J. Britten, and T. M. Lemaire, *Acta Cryst.*, **2008**, *E64*, o719.
14. W. L. Duax and D. A. Norton, *Atlas of Steroid Structure*, **1975**, Vol. 1. Plenum Press, New York.