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## Structure Reports

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 4-(1*H*-Benzimidazol-2-yl)benzonitrile

Wei Dai, Wen-Xiang Wang, Yu-Yuan Zhao and Hong Zhao\*

 Ordered Matter Science Research Center, College of Chemistry and Chemical Engineering, Southeast University, Nanjing 210096, People's Republic of China  
 Correspondence e-mail: zhaohong@seu.edu.cn

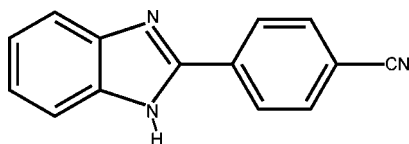
Received 19 April 2008; accepted 1 May 2008

 Key indicators: single-crystal X-ray study;  $T = 293$  K; mean  $\sigma(\text{C}-\text{C}) = 0.002$  Å;  $R$  factor = 0.046;  $wR$  factor = 0.119; data-to-parameter ratio = 16.2.

The molecule of the title compound,  $\text{C}_{14}\text{H}_9\text{N}_3$ , is essentially planar, the dihedral angle formed by the benzimidazole ring system with the benzene ring being  $3.87(3)^\circ$ . In the crystal packing, molecules are linked into zigzag chains running parallel to the  $b$  axis by intermolecular  $\text{N}-\text{H}\cdots\text{N}$  hydrogen-bond interactions.

## Related literature

For related literature, see: Gallagher *et al.* (2001); Howarth & Hanlon (2001); Kazak *et al.* (2006); Li *et al.* (1998); Íkizler & Sancak (1992).



## Experimental

## Crystal data

$\text{C}_{14}\text{H}_9\text{N}_3$   
 $M_r = 219.24$   
 Monoclinic,  $P2_1/n$   
 $a = 7.2172(10)$  Å  
 $b = 11.818(2)$  Å  
 $c = 12.719(2)$  Å  
 $\beta = 92.057(7)^\circ$

$V = 1084.1(3)$  Å<sup>3</sup>  
 $Z = 4$   
 Mo  $K\alpha$  radiation  
 $\mu = 0.08$  mm<sup>-1</sup>  
 $T = 293(2)$  K  
 $0.35 \times 0.15 \times 0.10$  mm

## Data collection

Rigaku Mercury2 diffractometer  
 Absorption correction: multi-scan  
 (*CrystalClear*; Rigaku, 2005)  
 $T_{\min} = 0.910$ ,  $T_{\max} = 1.000$   
 (expected range = 0.903–0.992)

11203 measured reflections  
 2581 independent reflections  
 2073 reflections with  $I > 2\sigma(I)$   
 $R_{\text{int}} = 0.037$

## Refinement

$R[F^2 > 2\sigma(F^2)] = 0.045$   
 $wR(F^2) = 0.118$   
 $S = 1.08$   
 2581 reflections  
 159 parameters

H atoms treated by a mixture of independent and constrained refinement  
 $\Delta\rho_{\max} = 0.16$  e Å<sup>-3</sup>  
 $\Delta\rho_{\min} = -0.17$  e Å<sup>-3</sup>

Table 1

Hydrogen-bond geometry (Å, °).

$D-\text{H}\cdots A$	$D-\text{H}$	$\text{H}\cdots A$	$D\cdots A$	$D-\text{H}\cdots A$
$\text{C13}-\text{H13A}\cdots\text{N1}$	0.93	2.54	2.861 (2)	101
$\text{N2}-\text{H2A}\cdots\text{N3}^i$	0.910 (17)	2.14 (2)	3.033 (2)	169.1 (15)

 Symmetry code: (i)  $-x + \frac{1}{2}, y + \frac{1}{2}, -z + \frac{1}{2}$ .

Data collection: *CrystalClear* (Rigaku, 2005); cell refinement: *CrystalClear*; data reduction: *CrystalClear*; program(s) used to solve structure: *SHELXS97* (Sheldrick, 2008); program(s) used to refine structure: *SHELXL97* (Sheldrick, 2008); molecular graphics: *SHELXTL* (Sheldrick, 2008); software used to prepare material for publication: *SHELXL97*.

This work was supported by a Start-up Grant from SEU to Professor Ren-Gen Xiong.

Supplementary data and figures for this paper are available from the IUCr electronic archives (Reference: RZ2211).

## References

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## supporting information

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**4-(1*H*-Benzimidazol-2-yl)benzonitrile**

**Wei Dai, Wen-Xiang Wang, Yu-Yuan Zhao and Hong Zhao**

**S1. Comment**

Benzimidazole systems continue to attract much attention in chemical synthesis, structural science and applied biological research (Li *et al.*, 1998; Gallagher *et al.*, 2001; Howarth & Hanlon, 2001; Kazak *et al.*, 2006). Nitriles are parent compounds for the preparation of various functional organic materials having triazole, imidazole or thiazole moieties (Íkizler & Sancak, 1992) and their derivatives have found many industrial applications. We report here the crystal structure of the title compound, 4-(1*H*-benzo[*d*]imidazol-2-yl) benzonitrile.

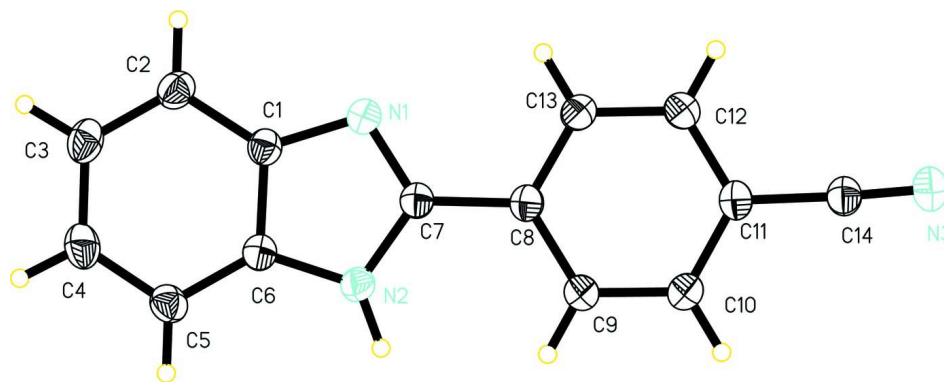
The structural analysis shows that in the title compound (Fig. 1) the benzimidazole ring system and the phenyl ring are nearly coplanar, the dihedral angle they form being 3.87 (3)°. In the imidazole ring, the C7δb N1 bond length of 1.3191 (16) Å conforms to the value for a double bond. The molecular conformation is stabilized by an intramolecular C—H...N hydrogen bond (Table 1). In the crystal structure, molecules are linked into zig-zag chains running parallel to the *b* axis by intermolecular N—H...N hydrogen bonding interactions involving the protonated N atom of the imidazole ring as H-donor and the N atom of the nitrile group as acceptor.

**S2. Experimental**

4-Formylbenzonitrile (2 mmol), malononitrile (1 mmol) and benzene-1,2-diamine (1 mmol) were heated at 100°C with stirring for 5 min. The mixture was washed with dichloromethane (5 mL) and dried. A white solid was obtained after recrystallization from ethanol. 4-(1*H*-Benzo[*d*]imidazol-2-yl)benzonitrile (0.3 mmol) was placed in a thick-walled Pyrex tube. EtOH (0.3 mL) and H<sub>2</sub>O (0.3 mL) were then added, the tube was frozen with liquid N<sub>2</sub>, evacuated and flame-sealed. The tube was heated at 100°C for 2 days to give colourless crystals of the title compound.

**S3. Refinement**

The H atom bound to the imidazole N atom was located in a difference Fourier synthesis and refined freely. All other H atoms were placed in calculated positions and refined using a riding model approximation, with C—H = 0.93 Å and  $U_{\text{iso}}(\text{H}) = 1.2 U_{\text{eq}}(\text{C})$ .



**Figure 1**

The molecular structure of the title compound with the atom-numbering scheme. Displacement ellipsoids are drawn at the 30% probability level.

#### 4-(1*H*-Benzimidazol-2-yl)benzonitrile

##### Crystal data

$C_{14}H_9N_3$

$M_r = 219.24$

Monoclinic,  $P2_1/n$

Hall symbol: -P 2yn

$a = 7.2172$  (10) Å

$b = 11.818$  (2) Å

$c = 12.719$  (2) Å

$\beta = 92.057$  (7)°

$V = 1084.1$  (3) Å<sup>3</sup>

$Z = 4$

$F(000) = 456$

$D_x = 1.343$  Mg m<sup>-3</sup>

Mo  $K\alpha$  radiation,  $\lambda = 0.71073$  Å

Cell parameters from 2461 reflections

$\theta = 3.2$ – $27.5$ °

$\mu = 0.08$  mm<sup>-1</sup>

$T = 293$  K

Prism, colourless

$0.35 \times 0.15 \times 0.10$  mm

##### Data collection

Rigaku Mercury2 (2x2 bin mode)  
diffractometer

Radiation source: fine-focus sealed tube

Graphite monochromator

Detector resolution: 13.6612 pixels mm<sup>-1</sup>

CCD\_Profile\_fitting scans

Absorption correction: multi-scan

(*CrystalClear*; Rigaku, 2005)

$T_{\min} = 0.911$ ,  $T_{\max} = 1.000$

11203 measured reflections

2581 independent reflections

2073 reflections with  $I > 2\sigma(I)$

$R_{\text{int}} = 0.037$

$\theta_{\max} = 27.9$ °,  $\theta_{\min} = 2.4$ °

$h = -9 \rightarrow 9$

$k = -15 \rightarrow 15$

$l = -16 \rightarrow 16$

##### Refinement

Refinement on  $F^2$

Least-squares matrix: full

$R[F^2 > 2\sigma(F^2)] = 0.046$

$wR(F^2) = 0.118$

$S = 1.08$

2581 reflections

159 parameters

0 restraints

Primary atom site location: structure-invariant  
direct methods

Secondary atom site location: difference Fourier  
map

Hydrogen site location: inferred from  
neighbouring sites

H atoms treated by a mixture of independent  
and constrained refinement

$w = 1/[\sigma^2(F_o^2) + (0.056P)^2 + 0.1336P]$

where  $P = (F_o^2 + 2F_c^2)/3$

$(\Delta/\sigma)_{\max} < 0.001$

$\Delta\rho_{\max} = 0.16$  e Å<sup>-3</sup>

$\Delta\rho_{\min} = -0.17$  e Å<sup>-3</sup>

Extinction correction: *SHELXL97* (Sheldrick,  
2008),  $F_c^* = kF_c[1 + 0.001x F_c^2 \lambda^3 / \sin(2\theta)]^{-1/4}$

Extinction coefficient: 0.115 (7)

*Special details*

**Geometry.** All e.s.d.'s (except the e.s.d. in the dihedral angle between two l.s. planes) are estimated using the full covariance matrix. The cell e.s.d.'s are taken into account individually in the estimation of e.s.d.'s in distances, angles and torsion angles; correlations between e.s.d.'s in cell parameters are only used when they are defined by crystal symmetry. An approximate (isotropic) treatment of cell e.s.d.'s is used for estimating e.s.d.'s involving l.s. planes.

**Refinement.** Refinement of  $F^2$  against ALL reflections. The weighted  $R$ -factor  $wR$  and goodness of fit  $S$  are based on  $F^2$ , conventional  $R$ -factors  $R$  are based on  $F$ , with  $F$  set to zero for negative  $F^2$ . The threshold expression of  $F^2 > \sigma(F^2)$  is used only for calculating  $R$ -factors(gt) etc. and is not relevant to the choice of reflections for refinement.  $R$ -factors based on  $F^2$  are statistically about twice as large as those based on  $F$ , and  $R$ -factors based on ALL data will be even larger.

*Fractional atomic coordinates and isotropic or equivalent isotropic displacement parameters ( $\text{\AA}^2$ )*

	<i>x</i>	<i>y</i>	<i>z</i>	$U_{\text{iso}}^*/U_{\text{eq}}$
N2	0.23276 (15)	0.98417 (9)	-0.07818 (9)	0.0381 (3)
C8	0.14908 (17)	0.84634 (11)	0.06171 (10)	0.0367 (3)
N1	0.08189 (15)	0.82641 (9)	-0.12784 (8)	0.0404 (3)
C7	0.15245 (17)	0.88501 (10)	-0.04772 (10)	0.0360 (3)
N3	0.11261 (18)	0.68424 (11)	0.45407 (10)	0.0543 (3)
C11	0.13598 (18)	0.76582 (11)	0.26664 (10)	0.0389 (3)
C6	0.21340 (17)	0.98948 (10)	-0.18604 (10)	0.0363 (3)
C9	0.23427 (19)	0.90578 (12)	0.14485 (10)	0.0439 (3)
H9A	0.2963	0.9730	0.1315	0.053*
C1	0.11833 (17)	0.89042 (11)	-0.21590 (10)	0.0377 (3)
C5	0.2689 (2)	1.06900 (11)	-0.25904 (11)	0.0443 (3)
H5A	0.3300	1.1351	-0.2384	0.053*
C14	0.12508 (18)	0.72221 (12)	0.37201 (11)	0.0425 (3)
C13	0.05688 (19)	0.74595 (12)	0.08336 (11)	0.0432 (3)
H13A	-0.0015	0.7058	0.0287	0.052*
C12	0.05122 (19)	0.70550 (12)	0.18459 (11)	0.0436 (3)
H12A	-0.0093	0.6378	0.1980	0.052*
C10	0.2277 (2)	0.86617 (12)	0.24669 (11)	0.0459 (3)
H10A	0.2846	0.9066	0.3017	0.055*
C4	0.2292 (2)	1.04531 (13)	-0.36315 (11)	0.0496 (4)
H4A	0.2652	1.0964	-0.4142	0.060*
C3	0.1362 (2)	0.94670 (13)	-0.39450 (11)	0.0492 (4)
H3A	0.1134	0.9332	-0.4658	0.059*
C2	0.07759 (19)	0.86882 (12)	-0.32224 (10)	0.0451 (3)
H2B	0.0131	0.8041	-0.3435	0.054*
H2A	0.281 (2)	1.0377 (15)	-0.0336 (13)	0.058 (5)*

*Atomic displacement parameters ( $\text{\AA}^2$ )*

	$U^{11}$	$U^{22}$	$U^{33}$	$U^{12}$	$U^{13}$	$U^{23}$
N2	0.0439 (6)	0.0349 (6)	0.0354 (6)	0.0001 (4)	0.0010 (5)	-0.0012 (4)
C8	0.0358 (6)	0.0391 (7)	0.0352 (7)	0.0032 (5)	0.0033 (5)	0.0003 (5)
N1	0.0455 (6)	0.0407 (6)	0.0349 (6)	-0.0031 (5)	-0.0001 (4)	0.0003 (4)
C7	0.0377 (6)	0.0355 (6)	0.0350 (7)	0.0035 (5)	0.0025 (5)	0.0001 (5)
N3	0.0641 (8)	0.0563 (8)	0.0425 (7)	-0.0005 (6)	0.0002 (6)	0.0094 (6)
C11	0.0391 (7)	0.0420 (7)	0.0357 (7)	0.0050 (5)	0.0029 (5)	0.0042 (5)

C6	0.0382 (6)	0.0351 (7)	0.0357 (7)	0.0050 (5)	0.0020 (5)	0.0003 (5)
C9	0.0535 (8)	0.0389 (7)	0.0393 (8)	-0.0058 (6)	-0.0006 (6)	0.0025 (5)
C1	0.0394 (6)	0.0375 (7)	0.0360 (7)	0.0042 (5)	-0.0002 (5)	0.0023 (5)
C5	0.0502 (8)	0.0360 (7)	0.0468 (8)	0.0010 (6)	0.0028 (6)	0.0046 (6)
C14	0.0468 (8)	0.0425 (7)	0.0381 (7)	0.0035 (5)	0.0011 (6)	0.0026 (5)
C13	0.0463 (7)	0.0464 (8)	0.0369 (7)	-0.0059 (6)	0.0000 (5)	-0.0026 (6)
C12	0.0461 (7)	0.0434 (7)	0.0414 (7)	-0.0061 (6)	0.0034 (6)	0.0025 (6)
C10	0.0549 (8)	0.0448 (8)	0.0376 (7)	-0.0049 (6)	-0.0038 (6)	-0.0009 (6)
C4	0.0590 (9)	0.0472 (8)	0.0430 (8)	0.0079 (6)	0.0050 (6)	0.0122 (6)
C3	0.0611 (9)	0.0508 (8)	0.0354 (7)	0.0113 (7)	-0.0042 (6)	0.0050 (6)
C2	0.0519 (8)	0.0439 (7)	0.0390 (7)	0.0023 (6)	-0.0058 (6)	-0.0016 (6)

*Geometric parameters (Å, °)*

N2—C7	1.3696 (16)	C9—C10	1.3798 (19)
N2—C6	1.3754 (17)	C9—H9A	0.9300
N2—H2A	0.910 (17)	C1—C2	1.3972 (18)
C8—C13	1.3926 (19)	C5—C4	1.374 (2)
C8—C9	1.3940 (19)	C5—H5A	0.9300
C8—C7	1.4661 (17)	C13—C12	1.3756 (18)
N1—C7	1.3191 (16)	C13—H13A	0.9300
N1—C1	1.3846 (16)	C12—H12A	0.9300
N3—C14	1.1427 (17)	C10—H10A	0.9300
C11—C10	1.3861 (19)	C4—C3	1.396 (2)
C11—C12	1.3877 (19)	C4—H4A	0.9300
C11—C14	1.4407 (18)	C3—C2	1.378 (2)
C6—C5	1.3901 (18)	C3—H3A	0.9300
C6—C1	1.4025 (18)	C2—H2B	0.9300
C7—N2—C6	107.00 (11)	C4—C5—C6	116.80 (13)
C7—N2—H2A	125.0 (10)	C4—C5—H5A	121.6
C6—N2—H2A	127.8 (10)	C6—C5—H5A	121.6
C13—C8—C9	118.70 (12)	N3—C14—C11	177.40 (16)
C13—C8—C7	118.53 (12)	C12—C13—C8	120.77 (13)
C9—C8—C7	122.77 (12)	C12—C13—H13A	119.6
C7—N1—C1	105.01 (11)	C8—C13—H13A	119.6
N1—C7—N2	112.72 (11)	C13—C12—C11	119.89 (13)
N1—C7—C8	123.42 (12)	C13—C12—H12A	120.1
N2—C7—C8	123.84 (11)	C11—C12—H12A	120.1
C10—C11—C12	120.16 (12)	C11—C10—C9	119.67 (13)
C10—C11—C14	121.25 (12)	C11—C10—H10A	120.2
C12—C11—C14	118.59 (12)	C9—C10—H10A	120.2
N2—C6—C5	132.50 (12)	C5—C4—C3	121.81 (13)
N2—C6—C1	105.27 (11)	C5—C4—H4A	119.1
C5—C6—C1	122.23 (12)	C3—C4—H4A	119.1
C10—C9—C8	120.80 (13)	C2—C3—C4	121.54 (14)
C10—C9—H9A	119.6	C2—C3—H3A	119.2
C8—C9—H9A	119.6	C4—C3—H3A	119.2

N1—C1—C2	130.07 (12)	C3—C2—C1	117.69 (13)
N1—C1—C6	110.01 (11)	C3—C2—H2B	121.2
C2—C1—C6	119.91 (12)	C1—C2—H2B	121.2

*Hydrogen-bond geometry (Å, °)*

<i>D—H...A</i>	<i>D—H</i>	<i>H...A</i>	<i>D...A</i>	<i>D—H...A</i>
C13—H13A...N1	0.93	2.54	2.861 (2)	101
N2—H2A...N3 <sup>i</sup>	0.910 (17)	2.14 (2)	3.033 (2)	169.1 (15)

Symmetry code: (i)  $-x+1/2, y+1/2, -z+1/2$ .