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2-(4-Methylphenyl)benzonitrile

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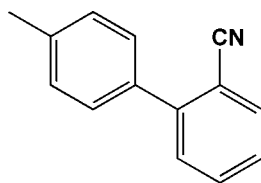
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 Key indicators: single-crystal X-ray study; $T = 173$ K; mean $\sigma(\text{C}-\text{C}) = 0.003$ Å; R factor = 0.040; wR factor = 0.105; data-to-parameter ratio = 11.3.

In the title compound, $\text{C}_{14}\text{H}_{11}\text{N}$, the dihedral angle between the mean planes of the two benzene rings is $44.6(7)^\circ$. The crystal packing is stabilized by weak intermolecular $\pi-\pi$ stacking interactions, the centroid-centroid distances being $3.8172(12)$ and $3.9349(12)$ Å.

Related literature

For the synthesis of pharmaceutically active compounds, see: Gillis & Markham (1997); Markham & Goa (1997). For related structures, see: Gerkin (1998); Narasegowda *et al.* (2005); Yathirajan *et al.* (2005). For standard bond lengths, see Allen *et al.* (1987).



Experimental

Crystal data

$\text{C}_{14}\text{H}_{11}\text{N}$	$V = 1071.18(9)$ Å ³
$M_r = 193.24$	$Z = 4$
Orthorhombic, $P2_12_12_1$	Mo $K\alpha$ radiation
$a = 7.6726(4)$ Å	$\mu = 0.07$ mm ⁻¹
$b = 11.4037(5)$ Å	$T = 173$ K
$c = 12.2426(5)$ Å	$0.30 \times 0.25 \times 0.20$ mm

Data collection

Oxford Diffraction Xcalibur Eos Gemini diffractometer	3786 measured reflections
Absorption correction: multi-scan (<i>CrysAlis RED</i> ; Oxford Diffraction, 2010)	1546 independent reflections
$T_{\min} = 0.979$, $T_{\max} = 0.986$	1322 reflections with $I > 2\sigma(I)$
	$R_{\text{int}} = 0.017$

Refinement

$R[F^2 > 2\sigma(F^2)] = 0.040$	137 parameters
$wR(F^2) = 0.105$	H-atom parameters constrained
$S = 1.07$	$\Delta\rho_{\max} = 0.22$ e Å ⁻³
1546 reflections	$\Delta\rho_{\min} = -0.14$ e Å ⁻³

Data collection: *CrysAlis PRO* (Oxford Diffraction, 2010); cell refinement: *CrysAlis PRO*; data reduction: *CrysAlis RED* (Oxford Diffraction, 2010); 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: *SHELXTL*.

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Supplementary data and figures for this paper are available from the IUCr electronic archives (Reference: XU5222).

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supporting information

Acta Cryst. (2011). E67, o1647 [doi:10.1107/S160053681101988X]

2-(4-Methylphenyl)benzotrile

M. S. Siddegowda, Jerry P. Jasinski, James A. Golen and H. S. Yathirajan

S1. Comment

The title compound, C₁₄H₁₁N, (I), is used to synthesize various biologically active and pharmaceutical compounds viz., losartan, valsartan, candesartan, etc. (Gillis & Markham, 1997; Markham & Goa, 1997). The crystal structures of 4,4'-dimethylbiphenyl-2,2'-dicarboxylic acid (Gerkin, 1998), 4'-methylbiphenyl-2-carboxylic acid (Narasegowda *et al.*, 2005) and 4'-(2-butyl-4-chloro-5-formylimidazol-1-ylmethyl)biphenyl-2-carbonitrile (Yathirajan *et al.*, 2005) have been reported. In view of its importance in order to determine the conformation of this molecule, a crystal structure determination of (I) is reported.

In the title compound, C₁₄H₁₁N, the dihedral angle between the mean planes of the two benzene rings is 44.6 (7)° (Fig. 1). Bond lengths and angles are in normal positions (Allen *et al.*, 1987). Crystal packing is stabilized by weak π - π stacking interactions (Fig. 2, Table 1).

S2. Experimental

The title compound was obtained as a gift sample from R. L. Fine Chem, Bangalore. X-ray quality crystals were obtained by slow evaporation of methanol solution (m.p.: 323-325 K).

S3. Refinement

All of the H atoms were placed in their calculated positions and then refined using the riding model with C—H = 0.95 Å (aromatic) or 0.98 Å (CH₃). Isotropic displacement parameters for these atoms were set to 1.19-1.21 (aromatic) or 1.50 (CH₃) times U_{eq} of the parent atom.

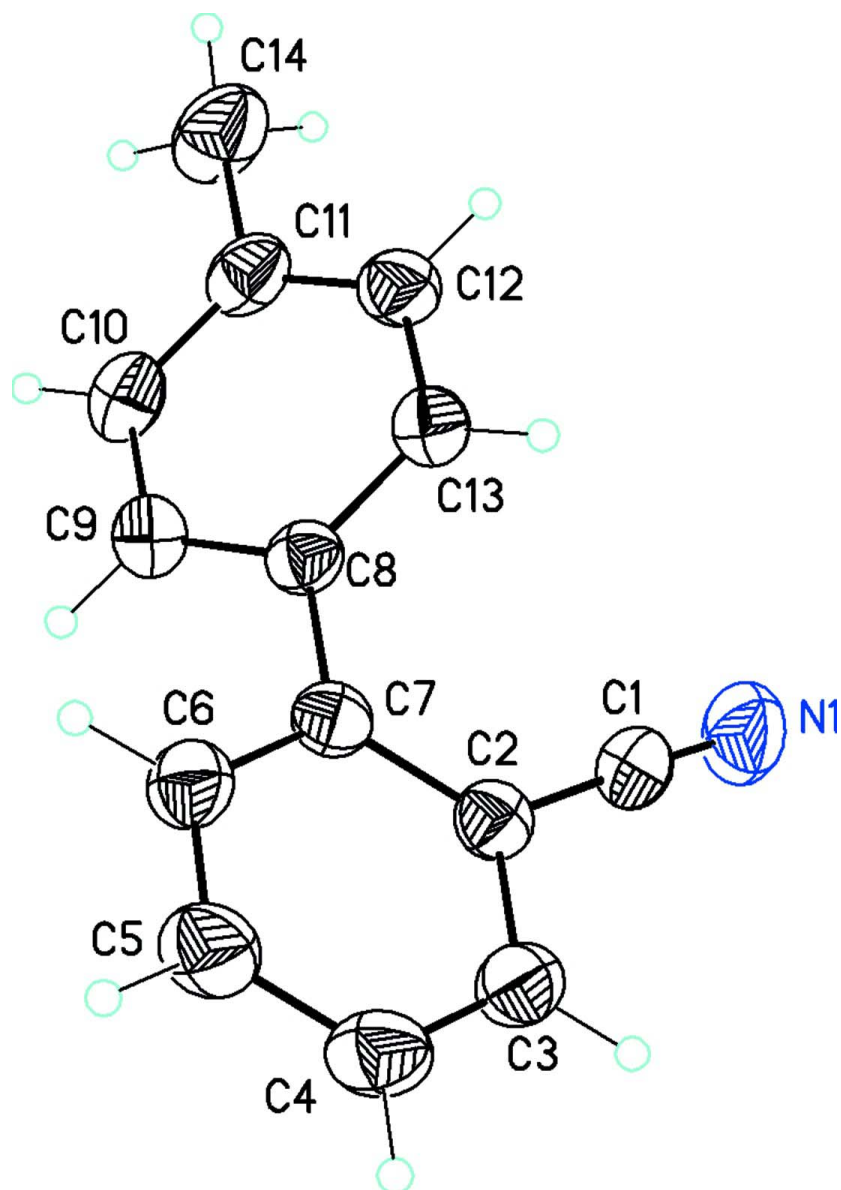
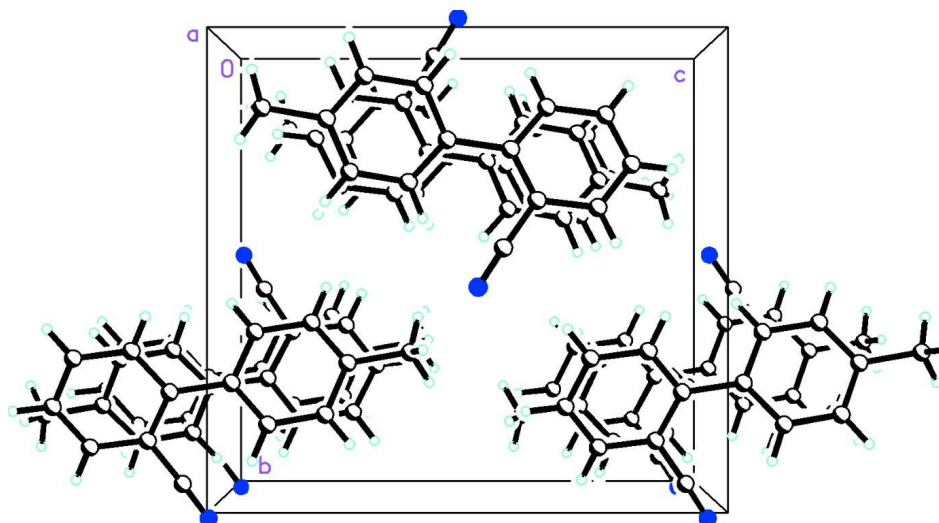


Figure 1

Molecular structure of the title compound showing the atom labeling scheme and 50% probability displacement ellipsoids.

**Figure 2**

Packing diagram of the title compound viewed down the *a* axis.

2-(4-Methylphenyl)benzonitrile

Crystal data

$C_{14}H_{11}N$

$M_r = 193.24$

Orthorhombic, $P2_12_12_1$

Hall symbol: $P\ 2ac\ 2ab$

$a = 7.6726\ (4)\ \text{\AA}$

$b = 11.4037\ (5)\ \text{\AA}$

$c = 12.2426\ (5)\ \text{\AA}$

$V = 1071.18\ (9)\ \text{\AA}^3$

$Z = 4$

$F(000) = 408$

$D_x = 1.198\ \text{Mg m}^{-3}$

Mo $K\alpha$ radiation, $\lambda = 0.71073\ \text{\AA}$

Cell parameters from 2201 reflections

$\theta = 3.3\text{--}32.3^\circ$

$\mu = 0.07\ \text{mm}^{-1}$

$T = 173\ \text{K}$

Block, colorless

$0.30 \times 0.25 \times 0.20\ \text{mm}$

Data collection

Oxford Diffraction Xcalibur Eos Gemini
diffractometer

Radiation source: Enhance (Mo) X-ray Source

Graphite monochromator

Detector resolution: $16.1500\ \text{pixels mm}^{-1}$

ω scans

Absorption correction: multi-scan

(*CrysAlis RED*; Oxford Diffraction, 2010)

$T_{\min} = 0.979$, $T_{\max} = 0.986$

3786 measured reflections

1546 independent reflections

1322 reflections with $I > 2\sigma(I)$

$R_{\text{int}} = 0.017$

$\theta_{\max} = 28.3^\circ$, $\theta_{\min} = 3.3^\circ$

$h = -10 \rightarrow 10$

$k = -7 \rightarrow 15$

$l = -16 \rightarrow 16$

Refinement

Refinement on F^2

Least-squares matrix: full

$R[F^2 > 2\sigma(F^2)] = 0.040$

$wR(F^2) = 0.105$

$S = 1.07$

1546 reflections

137 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-atom parameters constrained

$w = 1/[\sigma^2(F_o^2) + (0.0516P)^2 + 0.1272P]$

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

$(\Delta/\sigma)_{\max} = 0.008$

$\Delta\rho_{\max} = 0.22\ \text{e \AA}^{-3}$

$\Delta\rho_{\min} = -0.14\ \text{e \AA}^{-3}$

Special details

Geometry. All esds (except the esd in the dihedral angle between two l.s. planes) are estimated using the full covariance matrix. The cell esds are taken into account individually in the estimation of esds in distances, angles and torsion angles; correlations between esds in cell parameters are only used when they are defined by crystal symmetry. An approximate (isotropic) treatment of cell esds is used for estimating esds 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 (\AA^2)

	<i>x</i>	<i>y</i>	<i>z</i>	$U_{\text{iso}}^*/U_{\text{eq}}$
N1	0.2954 (3)	0.53397 (15)	0.51932 (16)	0.0599 (5)
C1	0.2409 (3)	0.45620 (16)	0.56640 (15)	0.0403 (4)
C2	0.1730 (2)	0.36058 (15)	0.62994 (15)	0.0350 (4)
C3	0.1706 (3)	0.37476 (16)	0.74343 (15)	0.0413 (4)
H3A	0.2117	0.4456	0.7751	0.050*
C4	0.1091 (3)	0.28649 (19)	0.80918 (16)	0.0484 (5)
H4A	0.1060	0.2963	0.8862	0.058*
C5	0.0518 (3)	0.1835 (2)	0.76255 (16)	0.0498 (5)
H5A	0.0090	0.1223	0.8079	0.060*
C6	0.0559 (3)	0.16831 (18)	0.65050 (16)	0.0427 (5)
H6A	0.0171	0.0962	0.6202	0.051*
C7	0.1155 (2)	0.25620 (15)	0.58127 (13)	0.0331 (4)
C8	0.1185 (2)	0.23705 (15)	0.46123 (13)	0.0333 (4)
C9	0.1780 (3)	0.13095 (16)	0.41890 (16)	0.0412 (4)
H9A	0.2178	0.0715	0.4672	0.049*
C10	0.1798 (3)	0.11109 (17)	0.30733 (16)	0.0459 (5)
H10A	0.2211	0.0381	0.2804	0.055*
C11	0.1230 (3)	0.19495 (18)	0.23447 (15)	0.0441 (5)
C12	0.0627 (3)	0.30048 (18)	0.27609 (16)	0.0432 (5)
H12A	0.0224	0.3595	0.2275	0.052*
C13	0.0604 (2)	0.32112 (16)	0.38739 (15)	0.0383 (4)
H13A	0.0183	0.3941	0.4139	0.046*
C14	0.1238 (4)	0.1727 (2)	0.11270 (17)	0.0671 (7)
H14A	0.1788	0.2391	0.0753	0.101*
H14B	0.0038	0.1637	0.0867	0.101*
H14C	0.1895	0.1009	0.0972	0.101*

Atomic displacement parameters (\AA^2)

	U^{11}	U^{22}	U^{33}	U^{12}	U^{13}	U^{23}
N1	0.0834 (14)	0.0413 (9)	0.0550 (10)	-0.0116 (10)	0.0026 (11)	0.0037 (8)
C1	0.0460 (10)	0.0356 (8)	0.0393 (9)	0.0018 (9)	-0.0010 (9)	-0.0051 (8)
C2	0.0344 (9)	0.0356 (8)	0.0349 (8)	0.0027 (8)	0.0011 (7)	0.0004 (7)
C3	0.0423 (10)	0.0424 (9)	0.0391 (10)	0.0009 (9)	-0.0028 (8)	-0.0043 (8)
C4	0.0542 (12)	0.0583 (12)	0.0328 (8)	-0.0027 (11)	0.0002 (9)	0.0020 (9)
C5	0.0559 (12)	0.0539 (11)	0.0395 (9)	-0.0100 (11)	0.0019 (9)	0.0107 (9)

C6	0.0454 (10)	0.0414 (9)	0.0414 (10)	-0.0099 (9)	-0.0005 (8)	0.0031 (8)
C7	0.0298 (8)	0.0367 (8)	0.0329 (8)	0.0023 (8)	-0.0003 (7)	0.0009 (7)
C8	0.0303 (8)	0.0358 (8)	0.0337 (8)	-0.0045 (7)	-0.0004 (7)	0.0000 (7)
C9	0.0448 (10)	0.0347 (9)	0.0441 (10)	-0.0005 (8)	-0.0020 (9)	0.0007 (8)
C10	0.0526 (11)	0.0380 (9)	0.0472 (11)	-0.0031 (9)	0.0032 (10)	-0.0092 (8)
C11	0.0489 (11)	0.0468 (10)	0.0366 (8)	-0.0151 (10)	0.0036 (9)	-0.0039 (8)
C12	0.0477 (11)	0.0449 (10)	0.0370 (8)	-0.0057 (9)	-0.0049 (8)	0.0056 (8)
C13	0.0391 (9)	0.0359 (8)	0.0397 (9)	0.0017 (8)	-0.0019 (8)	-0.0009 (8)
C14	0.0991 (19)	0.0644 (13)	0.0378 (10)	-0.0186 (16)	0.0036 (13)	-0.0095 (11)

Geometric parameters (Å, °)

N1—C1	1.137 (2)	C8—C9	1.393 (2)
C1—C2	1.437 (2)	C9—C10	1.385 (3)
C2—C3	1.399 (2)	C9—H9A	0.9500
C2—C7	1.402 (2)	C10—C11	1.378 (3)
C3—C4	1.373 (3)	C10—H10A	0.9500
C3—H3A	0.9500	C11—C12	1.386 (3)
C4—C5	1.378 (3)	C11—C14	1.512 (3)
C4—H4A	0.9500	C12—C13	1.383 (3)
C5—C6	1.383 (3)	C12—H12A	0.9500
C5—H5A	0.9500	C13—H13A	0.9500
C6—C7	1.390 (2)	C14—H14A	0.9800
C6—H6A	0.9500	C14—H14B	0.9800
C7—C8	1.486 (2)	C14—H14C	0.9800
C8—C13	1.391 (2)		
N1—C1—C2	177.67 (19)	C10—C9—C8	120.81 (17)
C3—C2—C7	121.07 (17)	C10—C9—H9A	119.6
C3—C2—C1	117.04 (16)	C8—C9—H9A	119.6
C7—C2—C1	121.87 (15)	C11—C10—C9	121.45 (18)
C4—C3—C2	120.14 (18)	C11—C10—H10A	119.3
C4—C3—H3A	119.9	C9—C10—H10A	119.3
C2—C3—H3A	119.9	C10—C11—C12	118.03 (17)
C3—C4—C5	119.46 (17)	C10—C11—C14	121.3 (2)
C3—C4—H4A	120.3	C12—C11—C14	120.6 (2)
C5—C4—H4A	120.3	C13—C12—C11	120.95 (18)
C4—C5—C6	120.7 (2)	C13—C12—H12A	119.5
C4—C5—H5A	119.6	C11—C12—H12A	119.5
C6—C5—H5A	119.6	C12—C13—C8	121.25 (17)
C5—C6—C7	121.45 (19)	C12—C13—H13A	119.4
C5—C6—H6A	119.3	C8—C13—H13A	119.4
C7—C6—H6A	119.3	C11—C14—H14A	109.5
C6—C7—C2	117.15 (15)	C11—C14—H14B	109.5
C6—C7—C8	120.14 (16)	H14A—C14—H14B	109.5
C2—C7—C8	122.70 (15)	C11—C14—H14C	109.5
C13—C8—C9	117.51 (16)	H14A—C14—H14C	109.5
C13—C8—C7	122.45 (16)	H14B—C14—H14C	109.5

C9—C8—C7	120.03 (16)		
C7—C2—C3—C4	-1.0 (3)	C6—C7—C8—C9	-43.5 (2)
C1—C2—C3—C4	-179.36 (18)	C2—C7—C8—C9	135.8 (2)
C2—C3—C4—C5	0.8 (3)	C13—C8—C9—C10	0.4 (3)
C3—C4—C5—C6	0.1 (3)	C7—C8—C9—C10	179.27 (18)
C4—C5—C6—C7	-0.8 (3)	C8—C9—C10—C11	-0.1 (3)
C5—C6—C7—C2	0.6 (3)	C9—C10—C11—C12	-0.3 (3)
C5—C6—C7—C8	179.9 (2)	C9—C10—C11—C14	-179.5 (2)
C3—C2—C7—C6	0.3 (3)	C10—C11—C12—C13	0.3 (3)
C1—C2—C7—C6	178.58 (18)	C14—C11—C12—C13	179.5 (2)
C3—C2—C7—C8	-179.05 (18)	C11—C12—C13—C8	0.1 (3)
C1—C2—C7—C8	-0.7 (3)	C9—C8—C13—C12	-0.5 (3)
C6—C7—C8—C13	135.2 (2)	C7—C8—C13—C12	-179.24 (17)
C2—C7—C8—C13	-45.5 (3)		
