Acta Crystallographica Section E
Structure Reports Online
ISSN 1600-5368

3-Bromo-2-(2-bromo-4,5-dimethoxybenzyl)-1-phenylsulfonyl-1*H*-indole

T. Ravishankar,[a] K. Chinnakali,[a]* N. Arumugam,[b] P. C. Srinivasan,[b] Anwar Usman[c] and Hoong-Kun Fun[c]*

[a]Department of Physics, Anna University, Chennai 600 025, India, [b]Department of Organic Chemistry, University of Madras, Guindy Campus, Chennai 600 025, India, and [c]X-ray Crystallography Unit, School of Physics, Universiti Sains Malaysia, 11800 USM, Penang, Malaysia

Correspondence e-mail: kali@annauniv.edu, hkfun@usm.my

Key indicators

Single-crystal X-ray study
T = 293 K
Mean σ(C–C) = 0.005 Å
R factor = 0.042
wR factor = 0.100
Data-to-parameter ratio = 18.7

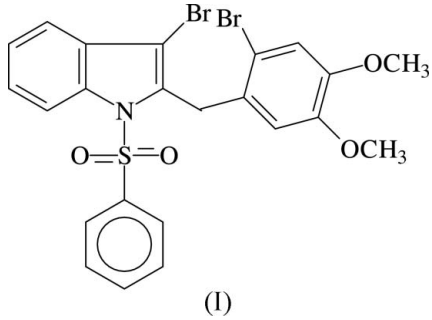
For details of how these key indicators were automatically derived from the article, see http://journals.iucr.org/e.

Received 3 March 2005
Accepted 8 March 2005
Online 18 March 2005

In the title compound, $C_{19}H_{15}BrN_2O_4S$, the orientations of the phenylsulfonyl and 2-bromo-4,5-dimethoxybenzyl substituents with respect to the indole moiety are influenced by intramolecular C—H···O and C—H···Br interactions. The sulfonyl-bound phenyl ring forms a dihedral angle of 86.9 (1)° with the mean plane through the indole ring system.

Comment

Indole derivatives have been found to exhibit antibacterial, antifungal (Wang & Ng, 2002; Singh *et al.*, 2000; Tsotinis *et al.*, 1997; Quetin-Leclercq *et al.*, 1995) and antitumour activities (Andreani *et al.*, 2001; Bradlow *et al.*, 1999; Cirrincione *et al.*, 1999; Tiwari *et al.*, 1994; Dashwood *et al.*, 1994). Certain indole derivatives are used as neuroprotectants (Stolc, 1999). Polyhalogenated indole derivatives exhibit marked antimicrobial activity against Gram-positive and Gram-negative bacteria and fungi (Piscopo, Diurno, Mazzoni & Ciaccio, 1990; Piscopo, Diurno, Mazzoni, Ciaccio & Veneruso, 1990). Some of the indole alkaloids extracted from plants possess interesting cytotoxic, antitumour or antiparasitic properties (Quetin-Leclercq, 1994; Mukhopadhyay *et al.*, 1981). Pyrido[1,2-*a*]-indole derivatives have been identified as potent inhibitors of human immunodeficiency virus type 1 (Taylor *et al.*, 1999), and 5-chloro-3-(phenylsulfonyl)indole-2-carboxamide is reported to be a highly potent non-nucleoside inhibitor of HIV-1 reverse transcriptase (Williams *et al.*, 1993). The title compound, (I), is an indole derivative and, when dissolved in ethyl acetate, it is found to exhibit relative antibacterial activity against *E. coli*, with a minimum inhibitory concentration (MIC) of 1024 and 2048 μg ml^{-1} (Ravishankar, Chinnakali, Arumugam & Srinivasan, 2003). As part of our investigations of indole derivatives, we have undertaken the X-ray structure analysis of (I) and present the results here.



(I)

The indole ring system in (I) (Fig. 1) is planar, with a maximum deviation of 0.030 (3) Å for atom C8. As a result of the electron-withdrawing character of the phenylsulfonyl group, the N—C*sp*^{2} bond lengths, *viz*. N1—C1 [1.428 (4) Å]

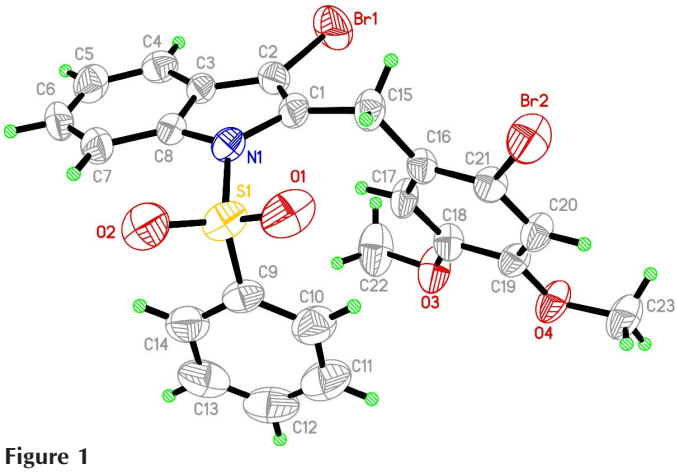


Figure 1
The structure of (I), showing the atom-numbering scheme and 50% probability displacement ellipsoids.

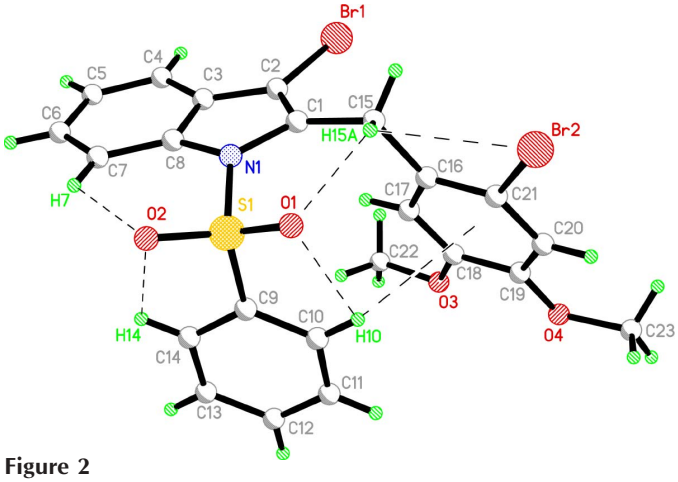


Figure 2
A view of the intramolecular interactions (dashed lines) in (I).

and N1—C8 [1.418 (4) Å], are longer than the mean value reported for N atoms with planar [1.355 (14) Å] configurations (Allen *et al.*, 1987). The bond angles of the fused benzene ring of the indole moiety are normal. The S—N, S—O and S—C distances are comparable with the values reported for other phenylsulfonylindoles (Ravishankar, Chinnakali, Arumugam, Srinivasan *et al.*, 2003*a*,*b*; Malathy Sony *et al.*, 2005). Atom S1 has a distorted tetrahedral configuration, with the O1—S1—O2 [120.57 (18)°] and N1—S1—C9 [105.32 (15)°] angles deviating significantly from ideal tetrahedral values. The orientation of the phenylsulfonyl group with respect to the indole moiety is described by the torsion angles O1—S1—N1—C1 = 37.3 (3)°, O2—S1—N1—C8 = −40.1 (3)° and N1—S1—C9—C10 = 98.6 (3)°. This orientation is influenced by intramolecular C—H···O interactions, namely C7—H7···O2, C14—H14···O2, C15—H15*A*···O1 and C10—H10···O1 (Table 1), involving the sulfonyl atoms O1 and O2; these deviate by 0.170 (5) and 0.112 (5) Å, respectively, from the plane of the indole ring system. As seen in Fig. 2, each of these interactions generates rings of graph-set motif *S*(5) or *S*(6) (Bernstein *et al.*, 1995; Etter, 1990).

The dihedral angle between the C9—C14 phenyl ring and the indole ring system is 86.9 (1)°. The N1—C1—C15—C16 torsion angle of 100.5 (4)° describes the orientation of the 2-bromo-4,5-dimethoxybenzyl substituent with respect to the indole ring system and the C1—C15—C16—C17 torsion angle of 15.5 (5)° shows how the C16–C21 benzene ring is oriented. This orientation is influenced by the intramolecular C15—H15*A*···Br2 interaction, which generates a ring of graph-set motif *S*(5) (Fig. 2). The C22—O3—C18—C17 [4.7 (5)°] and C23—O4—C19—C20 [−3.3 (5)°] torsion angles indicate that the two methoxy substituents are coplanar with the attached ring. The dihedral angle between the mean planes through the C9–C14 and C16–C21 aromatic rings is 25.1 (2)°. The centroids of these two rings are separated by 4.686 (3) Å, and hence there is no π–π interaction between them. However, a C—H···π interaction involving atom H10 and the C16–C21 ring is observed, with H10 separated from the centroid (*Cg*1) of the ring by 3.07 Å (Table 1). The C—H···π interactions involving the methylene H atom, H15*B*, and the benzene ring (centroid *Cg*2) of the indole ring system link the inversion-related molecules at (x, y, z) and ($-x$, $1-y$, $-z$) into a centrosymmetric dimer. The dimer structure is further stabilized by the π–π stacking interaction between the pyrrole rings of the indole moieties; the centroid–centroid distance between the pyrrole rings is 3.678 (2) Å and the perpendicular distance is 3.573 (2) Å.

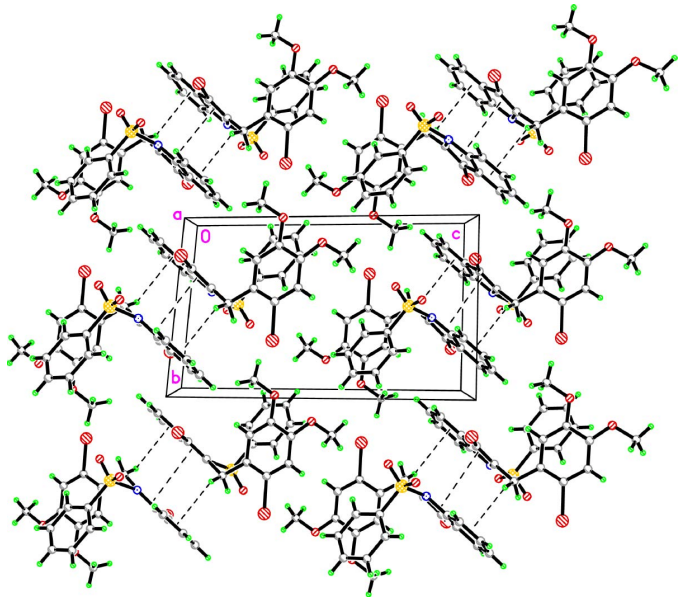


Figure 3
The crystal packing in (I), showing the dimers. C—H···π and π–π interactions are shown as dashed lines.

A view of the molecular packing down the *a* axis, illustrating the dimer formation, is shown in Fig. 3. The dimers are linked through C—H···Br and C—H···O intermolecular interactions (Table 1).

Experimental

To a solution of 3-bromo-1-phenylsulfonylindol-2-ylmethanol (3.6 g, 10 mmol) in chloroform (200 ml), a solution of 4-bromo-3-methoxyacetanilide (2.26, 10 mmol) in the same solvent (25 ml) was added, followed by anhydrous magnesium sulfate (10 g) and boron

trifluoride etherate (2.0 ml). The resulting solution was refluxed for 3 h. Water (100 ml) was then added and the organic layer was separated. The organic layer was washed with 20% hydrochloric acid (1 × 50 ml), followed by water and saturated sodium bicarbonate solution. The solvent was removed by distillation, after drying over anhydrous sodium sulfate. The residue was chromatographed on a silica-gel column (350 mesh) and eluted successively with 20%, 25% and 30% ethyl acetate in hexane. The 30% ethyl acetate eluent gave the title compound, which was then crystallized from hexane:chloroform (2:1).

Crystal data

$C_{23}H_{19}Br_2NO_4S$
M_r = 565.27
Triclinic, $P\overline{1}$
a = 8.7855 (7) Å
b = 9.8033 (7) Å
c = 14.874 (1) Å
α = 88.368 (1)°
β = 79.065 (1)°
γ = 64.090 (1)°
V = 1129.21 (15) Å^3
Z = 2
D_x = 1.662 Mg m^{-3}
Mo $K\alpha$ radiation
Cell parameters from 2278 reflections
θ = 2.3–25.4°
μ = 3.71 mm^{-1}
T = 293 (2) K
Block, colourless
0.44 × 0.40 × 0.18 mm

Data collection

Siemens SMART CCD area-detector diffractometer
ω scans
Absorption correction: multi-scan (*SADABS*; Sheldrick, 1996)
T_{min} = 0.270, T_{max} = 0.513
7173 measured reflections
5306 independent reflections
3299 reflections with $I > 2\sigma(I)$
R_{int} = 0.019
θ_{max} = 28.3°
$h = -11 \rightarrow 11$
$k = -13 \rightarrow 13$
$l = -19 \rightarrow 10$

Refinement

Refinement on F^2
$R[F^2 > 2\sigma(F^2)]$ = 0.042
$wR(F^2)$ = 0.100
S = 1.00
5306 reflections
283 parameters
H-atom parameters constrained
$w = 1/[\sigma^2(F_o^2) + (0.0335P)^2 + 0.7566P]$ where $P = (F_o^2 + 2F_c^2)/3$
$(\Delta/\sigma)_{max}$ = 0.001
$\Delta\rho_{max}$ = 0.43 e Å^{-3}
$\Delta\rho_{min}$ = −0.45 e Å^{-3}
Extinction correction: *SHELXTL* (Sheldrick, 1997)
Extinction coefficient: 0.0063 (7)

Table 1
Hydrogen-bond geometry (Å, °).

D—H···A	D—H	H···A	D···A	D—H···A
C7—H7···O2	0.93	2.32	2.909 (4)	121
C10—H10···O1	0.93	2.56	2.920 (5)	104
C14—H14···O2	0.93	2.67	2.978 (5)	100
C15—H15A···Br2	0.97	2.85	3.169 (4)	100
C15—H15A···O1	0.97	2.26	2.926 (6)	125
C6—H6···Br1^{i}	0.93	2.99	3.587 (5)	124
C12—H12···O4^{ii}	0.93	2.71	3.558 (6)	153
C22—H22A···O1^{iii}	0.96	2.80	3.492 (5)	130
C23—H23B···O1^{iv}	0.96	2.70	3.161 (5)	110
C23—H23A···O3^{v}	0.96	2.54	3.406 (6)	150
C10—H10···$Cg1$	0.93	3.07	3.632 (6)	120
C15—H15B···$Cg2^{vi}$	0.97	2.91	3.506 (4)	121

Symmetry codes: (i) $x-1, y, z$; (ii) $-x, -y, -z+1$; (iii) $x+1, y-1, z$; (iv) $-x, -y+1, -z+1$; (v) $-x+1, -y, -z+1$; (vi) $-x, -y+1, -z$. $Cg1$ is the centroid of the C16–C21 ring and $Cg2$ is the centroid of the C3–C8 ring.

The H atoms were positioned geometrically and treated as riding on their parent C atoms, with C—H distances of 0.93 (aromatic), 0.97 (methylene) and 0.96 Å (methyl), and with U_{iso}(H) = 1.5U_{eq}(methyl C) and 1.2U_{eq}(other C atoms).

Data collection: *SMART* (Siemens, 1996); cell refinement: *SAINT* (Siemens, 1996); data reduction: *SAINT*; program(s) used to solve structure: *SHELXTL* (Sheldrick, 1997); program(s) used to refine structure: *SHELXTL*; molecular graphics: *SHELXTL*; software used to prepare material for publication: *SHELXTL* and *PLATON* (Spek, 2003).

HKF thanks the Malaysian Government and Universiti Sains Malaysia for research grant R&D No. 305/PFIZIK/610961.

References

Allen, F. H., Kennard, O., Watson, D. G., Brammer, L., Orpen, A. G. & Taylor, R. (1987). *J. Chem. Soc. Perkin Trans. 2*, pp. S1–S19.
Andreani, A., Granaiola, M., Leoni, A., Locatelli, A., Morigi, R., Rambaldi, M., Giorgi, G., Salvini, L. & Garaliene, V. (2001). *Anticancer Drug Des.* **16**, 167–174.
Bernstein, J., Davis, R. E., Shimoni, L. & Chang, N. (1995). *Angew. Chem. Int. Ed. Engl.* **34**, 1555–1573.
Bradlow, H. L., Sepkovic, D. W., Telang, N. T. & Osborne, M. P. (1999). *Ann. N. Y. Acad. Sci.* **889**, 204–213.
Cirrincione, G., Almerico, A. M., Barraja, P., Diana, P., Lauria, A., Passannanti, A., Musiu, C., Pani, A., Murtas, P., Minnei, C., Marongiu, M. E. & La Colla, P. (1999). *J. Med. Chem.* **42**, 2561–2568.
Dashwood, R. H., Fong, A. T., Arbogast, D. N., Bjeldanes, L. F., Hendricks, J. D. & Bailey, G. S. (1994). *Cancer Res.* **54**, 3617–3619.
Etter, M. C. (1990). *Acc. Chem. Res.* **23**, 120–126.
Malathy Sony, S. M., Palani, K., Charles, P., Ponnuswamy, M. N., Sureshbabu, N., Srinivasan, P. C. & Nethaji, M. (2005). *Acta Cryst.* E**61**, o521–o523.
Mukhopadhyay, S., Handy, G. A., Funayama, S. & Cordell, G. A. (1981). *J. Nat. Prod.* **44**, 696–700.
Piscopo, E., Diurno, M. V., Mazzoni, O. & Ciaccio, A. M. (1990). *Boll. Soc. Ital. Biol. Sper.* **66**, 1181–1186.
Piscopo, E., Diurno, M. V., Mazzoni, O., Ciaccio, A. M. & Veneruso, G. (1990). *Boll. Soc. Ital. Biol. Sper.* **66**, 1187–1191.
Quetin-Leclercq, J. (1994). *J. Pharm. Belg.* **49**, 181–192.
Quetin-Leclercq, J., Favel, A., Balansard, G., Regli, P. & Angenot, L. (1995). *Planta Med.* **61**, 475–477.
Ravishankar, T., Chinnakali, K., Arumugam, N. & Srinivasan, P. C. (2003). Unpublished results.
Ravishankar, T., Chinnakali, K., Arumugam, N., Srinivasan, P. C., Usman, A. & Fun, H.-K. (2003*a*). *Acta Cryst.* C**59**, o137–o140.
Ravishankar, T., Chinnakali, K., Arumugam, N., Srinivasan, P. C., Usman, A. & Fun, H.-K. (2003*b*). *Acta Cryst.* E**59**, o1903–o1906.
Sheldrick, G. M. (1996). *SADABS*. University of Göttingen, Germany.
Sheldrick, G. M. (1997). *SHELXTL*. Version 5.1. Bruker AXS Inc., Madison, Wisconsin, USA.
Siemens (1996). *SMART* and *SAINT*. Versions 4.0. Siemens Analytical X-Ray Instruments Inc., Madison, Wisconsin, USA.
Singh, U. P., Sarma, B. K., Mishra, P. K. & Ray, A. B. (2000). *Folia Microbiol.* **45**, 173–176.
Spek, A. L. (2003). *J. Appl. Cryst.* **36**, 7–13.
Stolc, S. (1999). *Life Sci.* **65**, 1943–1950.
Taylor, D. L., Ahmed, P. S., Chambers. P., Tyms, A. S., Bedard, J., Duchaine, J., Falardeau, G., Lavallee, J. F., Brown, W., Rando, R. F. & Bowlin, T. (1999). *Antiviral Chem. Chemother.* **10**, 79–86.
Tiwari, R. K., Guo, L., Bradlow, H. L., Telang, N. T. & Osborne, M. P. (1994). *J. Natl Cancer Inst.* **86**, 126–131.
Tsotinis, A., Varvaresou, A., Calogeropoulou, T., Siatra-Papastaikoudi, T. & Tiligada, A. (1997). *Arzneim. Forsch.* **47**, 307–310.
Wang, H. X. & Ng, T. B. (2002). *Comput. Biochem. Physiol. C Toxicol. Pharmacol.* **132**, 261–268.
Williams, T. M., Ciccarone, T. M., MacTough, S. C., Rooney, C. S., Balani, S. K., Condra, J. H., Emini, E. A., Goldman, M. E., Greenlee, W. J. & Kauffman, L. R. (1993). *J. Med. Chem.* **36**, 1291–1294.