

## N-(2-Chlorophenyl)-2-(4,6-dimethylpyrimidin-2-ylsulfanyl)acetamide

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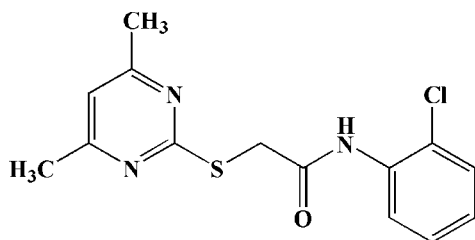
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Key indicators: single-crystal X-ray study;  $T = 113$  K; mean  $\sigma(\text{C}-\text{C}) = 0.003$  Å;  $R$  factor = 0.024;  $wR$  factor = 0.061; data-to-parameter ratio = 13.8.

In the title compound,  $\text{C}_{14}\text{H}_{14}\text{ClN}_3\text{OS}$ , the 4,6-dimethylpyrimidine ring and the chlorobenzene ring subtend a dihedral angle of  $80.0(2)^\circ$ . The length of the  $\text{Csp}^2-\text{S}$  bond is significantly shorter than that of the  $\text{Csp}^3-\text{S}$  bond. The crystal structure is stabilized by intermolecular  $\text{N}-\text{H}\cdots\text{O}$ ,  $\text{C}-\text{H}\cdots\text{O}$  and  $\text{C}-\text{H}\cdots\text{N}$  hydrogen bonding, and  $\text{C}-\text{H}\cdots\pi$  interactions.

### Related literature

For bond-length data, see: Gao *et al.* (2007). For heteroatom-rich compounds as effective precursors for active molecules, see: Huynh *et al.* (2005); Ye *et al.* (2006).



### Experimental

#### Crystal data

$\text{C}_{14}\text{H}_{14}\text{ClN}_3\text{OS}$   
 $M_r = 307.79$   
 Orthorhombic,  $Pca2_1$

$a = 26.494(5)$  Å  
 $b = 4.6736(9)$  Å  
 $c = 11.931(2)$  Å

$V = 1477.3(5)$  Å<sup>3</sup>  
 $Z = 4$   
 Mo  $K\alpha$  radiation

$\mu = 0.40$  mm<sup>-1</sup>  
 $T = 113$  K  
 $0.30 \times 0.26 \times 0.20$  mm

#### Data collection

Rigaku Saturn diffractometer  
 Absorption correction: multi-scan  
 (*SADABS*; Sheldrick, 1996)  
 $T_{\text{min}} = 0.890$ ,  $T_{\text{max}} = 0.925$

8870 measured reflections  
 2573 independent reflections  
 2445 reflections with  $I > 2\sigma(I)$   
 $R_{\text{int}} = 0.031$

#### Refinement

$R[F^2 > 2\sigma(F^2)] = 0.024$   
 $wR(F^2) = 0.061$   
 $S = 1.07$   
 2573 reflections  
 187 parameters  
 2 restraints

H atoms treated by a mixture of independent and constrained refinement  
 $\Delta\rho_{\text{max}} = 0.17$  e Å<sup>-3</sup>  
 $\Delta\rho_{\text{min}} = -0.20$  e Å<sup>-3</sup>  
 Absolute structure: Flack (1983), 1199 Friedel pairs  
 Flack parameter: 0.00 (5)

**Table 1**

Hydrogen-bond geometry (Å, °).

$D-H\cdots A$	$D-H$	$H\cdots A$	$D\cdots A$	$D-H\cdots A$
$\text{N1}-\text{H1}\cdots\text{O1}^{\text{i}}$	0.873 (11)	2.054 (12)	2.8414 (18)	149.6 (18)
$\text{C2}-\text{H2}\cdots\text{O1}^{\text{ii}}$	0.93	2.46	3.213 (2)	138
$\text{C8}-\text{H8A}\cdots\text{Cg1}^{\text{i}}$	0.97	2.92	3.832 (2)	157
$\text{C13}-\text{H13B}\cdots\text{Cg1}^{\text{iii}}$	0.96	2.99	3.592 (2)	122

Symmetry codes: (i)  $x, y + 1, z$ ; (ii)  $-x + 1, -y + 2, z + \frac{1}{2}$ ; (iii)  $x, y - 1, z$ .  $\text{Cg1}$  is the centroid of the  $\text{N2/N3/C9-C12}$  ring.

Data collection: *CrystalClear* (Molecular Structure Corporation & Rigaku, 1999); 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: *SHELXTL*.

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Supplementary data and figures for this paper are available from the IUCr electronic archives (Reference: AT2755).

### References

- Flack, H. D. (1983). *Acta Cryst.* **A39**, 876–881.  
 Gao, Y., Liang, D., Gao, L.-X., Fang, G.-J. & Wang, W. (2007). *Acta Cryst.* **E63**, o4854.  
 Huynh, M. H. V., Hiskey, M. A. & Archuleta, J. G. (2005). *Angew. Chem. Int. Ed.* **44**, 737–739.  
 Molecular Structure Corporation & Rigaku (1999). *CrystalClear*. MSC, The Woodlands, Texas, USA, and Rigaku Corporation, Tokyo, Japan.  
 Sheldrick, G. M. (1996). *SADABS*. University of Göttingen, Germany.  
 Sheldrick, G. M. (2008). *Acta Cryst.* **A64**, 112–122.  
 Ye, C. F., Gao, H. X. & Boatz, J. A. (2006). *Angew. Chem. Int. Ed.* **45**, 7262–7265.

**supplementary materials**

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## *N*-(2-Chlorophenyl)-2-(4,6-dimethylpyrimidin-2-ylsulfanyl)acetamide

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### Comment

The heteroatom-rich compounds have been intensively studied due to their applications including effective precursors for active molecule (Ye *et al.*, 2006; Huynh *et al.*, 2005). Now, we have synthesized the title compound, (I), from 4,6-dimethylpyrimidin-2-thiol with 2-chlorophenyl carbamic chloride. Here we report the crystal structure determination of the title compound.

The molecular structure of (I) and the atom-numbering scheme are shown in Fig. 1. The molecule contains a benzene ring and a pyrimidine ring. The dihedral angle between the benzene ring and benzo[*d*]thiazole ring is 80.0 (2)°, which indicate the two rings are close to be perpendicular. Cl atom attached to the benzene ring is coplanar to the benzene ring with an r.m.s deviation of 0.0130 (3) Å. The deviations with the pyrimidine ring plane of C13 and C14 atoms are 0.0544 (3) and 0.0005 (3) Å, respectively. The C6—N1—C7—C8 torsion angle of 177.61 (15)° indicates that the acylamide group are nearly coplanar with the benzene ring plane. As a result of  $\pi$ - $\pi$  conjugation, the  $Csp^2$ —S bond [S1—C9 = 1.7646 (17) Å] is significantly shorter than the  $Csp^3$ —S bond [S1—C8 = 1.7947 (17) Å]. These values compare with the values of 1.772 (3) and 1.801 (2) Å reported in the literature (Gao *et al.*, 2007).

The crystal structure is stabilized by inter molecular C—H $\cdots$ O and C—H $\cdots$ N hydrogen bonding, and C—H $\cdots$  $\pi$  interactions (Table 1).

### Experimental

The title compound was synthesized by the reaction of from the 4,6-dimethylpyrimidin-2-thiol with 2-chlorophenyl carbamic chloride in the refluxing ethanol. Crystals of (I) suitable for single-crystal X-ray analysis were grown by slow evaporation of a solution in chloroform/acetone.

### Refinement

The H atoms attached to N atom was located in a different density map and the atomic coordinates allowed to refine freely. Other H atoms were positioned geometrically and refined as riding (C—H = 0.93–0.97 Å) and allowed to ride on their parent atoms, with  $U_{iso}(H) = 1.2U_{eq}(parent)$  or  $1.5U_{eq}(parent)$ .

### Figures

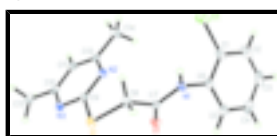


Fig. 1. View of the molecule of (I) showing the atom-labeling scheme. Displacement ellipsoids are drawn at the 35% probability level.

## *N*-(2-Chlorophenyl)-2-(4,6-dimethylpyrimidin-2-ylsulfanyl)acetamide

### Crystal data

$C_{14}H_{14}ClN_3OS$	$F_{000} = 640$
$M_r = 307.79$	$D_x = 1.384 \text{ Mg m}^{-3}$
Orthorhombic, $Pca2_1$	Mo $K\alpha$ radiation
Hall symbol: P 2c -2ac	$\lambda = 0.71073 \text{ \AA}$
$a = 26.494 (5) \text{ \AA}$	Cell parameters from 4682 reflections
$b = 4.6736 (9) \text{ \AA}$	$\theta = 1.5\text{--}27.9^\circ$
$c = 11.931 (2) \text{ \AA}$	$\mu = 0.40 \text{ mm}^{-1}$
$V = 1477.3 (5) \text{ \AA}^3$	$T = 113 \text{ K}$
$Z = 4$	Prism, colourless
	$0.30 \times 0.26 \times 0.20 \text{ mm}$

### Data collection

Rigaku Saturn diffractometer	2573 independent reflections
Radiation source: rotating anode	2445 reflections with $I > 2\sigma(I)$
Monochromator: confocal	$R_{\text{int}} = 0.031$
$T = 113 \text{ K}$	$\theta_{\text{max}} = 25.0^\circ$
$\omega$ scans	$\theta_{\text{min}} = 1.5^\circ$
Absorption correction: multi-scan (SADABS; Sheldrick, 1996)	$h = -23 \rightarrow 31$
$T_{\text{min}} = 0.890$ , $T_{\text{max}} = 0.925$	$k = -5 \rightarrow 5$
8870 measured reflections	$l = -14 \rightarrow 14$

### Refinement

Refinement on $F^2$	Hydrogen site location: inferred from neighbouring sites
Least-squares matrix: full	H atoms treated by a mixture of independent and constrained refinement
$R[F^2 > 2\sigma(F^2)] = 0.024$	$w = 1/[\sigma^2(F_o^2) + (0.0391P)^2]$
$wR(F^2) = 0.061$	where $P = (F_o^2 + 2F_c^2)/3$
$S = 1.07$	$(\Delta/\sigma)_{\text{max}} = 0.001$
2573 reflections	$\Delta\rho_{\text{max}} = 0.17 \text{ e \AA}^{-3}$
187 parameters	$\Delta\rho_{\text{min}} = -0.20 \text{ e \AA}^{-3}$
2 restraints	Extinction correction: none
Primary atom site location: structure-invariant direct methods	Absolute structure: Flack (1983), 1199 Freidel pairs
Secondary atom site location: difference Fourier map	Flack parameter: 0.00 (5)

*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>	$U_{\text{iso}}^*/U_{\text{eq}}$
S1	0.689926 (15)	1.07672 (8)	0.28992 (4)	0.02168 (11)
Cl1	0.53054 (2)	1.55461 (10)	0.63460 (4)	0.03848 (14)
O1	0.58637 (4)	0.8871 (2)	0.35668 (11)	0.0216 (3)
N1	0.55577 (5)	1.3204 (3)	0.40980 (12)	0.0193 (3)
N2	0.67886 (5)	1.0007 (3)	0.51049 (13)	0.0216 (3)
N3	0.74415 (5)	0.7412 (3)	0.41469 (12)	0.0198 (3)
C1	0.49282 (7)	1.3208 (4)	0.55761 (16)	0.0250 (4)
C2	0.44695 (7)	1.2326 (4)	0.60204 (17)	0.0353 (5)
H2	0.4361	1.3025	0.6710	0.042*
C3	0.41781 (7)	1.0427 (5)	0.5439 (2)	0.0403 (6)
H3	0.3873	0.9816	0.5740	0.048*
C4	0.43334 (7)	0.9406 (4)	0.44072 (19)	0.0350 (5)
H4	0.4134	0.8106	0.4017	0.042*
C5	0.47894 (6)	1.0334 (4)	0.39558 (18)	0.0254 (4)
H5	0.4891	0.9674	0.3256	0.031*
C6	0.50924 (6)	1.2233 (3)	0.45406 (14)	0.0204 (4)
C7	0.59151 (6)	1.1465 (3)	0.36648 (14)	0.0171 (3)
C8	0.63851 (6)	1.3054 (4)	0.32946 (15)	0.0233 (4)
H8A	0.6495	1.4287	0.3901	0.028*
H8B	0.6300	1.4267	0.2663	0.028*
C9	0.70557 (6)	0.9262 (3)	0.42103 (14)	0.0179 (3)
C10	0.75680 (6)	0.6156 (3)	0.51203 (15)	0.0201 (4)
C11	0.73123 (6)	0.6745 (4)	0.61057 (15)	0.0238 (4)
H11	0.7400	0.5841	0.6772	0.029*
C12	0.69218 (6)	0.8721 (4)	0.60723 (16)	0.0231 (4)
C13	0.80089 (7)	0.4138 (4)	0.50769 (18)	0.0280 (4)
H13A	0.8046	0.3412	0.4329	0.042*
H13B	0.7952	0.2576	0.5584	0.042*
H13C	0.8311	0.5135	0.5291	0.042*
C14	0.66199 (8)	0.9520 (5)	0.70853 (18)	0.0363 (5)
H14A	0.6604	1.1567	0.7146	0.054*
H14B	0.6778	0.8745	0.7743	0.054*
H14C	0.6285	0.8762	0.7016	0.054*

# supplementary materials

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H1                    0.5635 (7)                    1.500 (2)                    0.4204 (17)                    0.027 (5)\*

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

	$U^{11}$	$U^{22}$	$U^{33}$	$U^{12}$	$U^{13}$	$U^{23}$
S1	0.02112 (19)	0.0217 (2)	0.0222 (2)	0.00522 (16)	0.00482 (17)	0.0057 (2)
Cl1	0.0551 (3)	0.0323 (3)	0.0280 (3)	0.0023 (2)	0.0035 (2)	-0.0090 (2)
O1	0.0241 (6)	0.0138 (6)	0.0270 (7)	0.0011 (5)	0.0005 (5)	-0.0002 (5)
N1	0.0224 (7)	0.0105 (7)	0.0249 (8)	-0.0024 (5)	0.0059 (6)	-0.0004 (6)
N2	0.0201 (7)	0.0226 (7)	0.0221 (8)	-0.0003 (6)	0.0016 (6)	-0.0034 (7)
N3	0.0188 (7)	0.0180 (7)	0.0224 (8)	-0.0013 (5)	0.0005 (6)	0.0008 (6)
C1	0.0303 (9)	0.0197 (9)	0.0251 (9)	0.0060 (7)	0.0049 (7)	0.0054 (8)
C2	0.0357 (11)	0.0317 (10)	0.0386 (12)	0.0123 (8)	0.0153 (9)	0.0113 (9)
C3	0.0226 (9)	0.0422 (13)	0.0560 (15)	0.0027 (9)	0.0127 (9)	0.0221 (11)
C4	0.0235 (10)	0.0342 (11)	0.0474 (14)	-0.0054 (8)	-0.0060 (9)	0.0125 (10)
C5	0.0239 (9)	0.0234 (9)	0.0290 (10)	0.0000 (7)	-0.0017 (8)	0.0070 (8)
C6	0.0206 (9)	0.0163 (9)	0.0243 (9)	0.0042 (6)	0.0028 (7)	0.0052 (7)
C7	0.0207 (8)	0.0157 (8)	0.0150 (8)	0.0016 (6)	-0.0026 (6)	0.0016 (7)
C8	0.0232 (8)	0.0168 (8)	0.0299 (10)	0.0042 (7)	0.0048 (7)	0.0043 (7)
C9	0.0179 (8)	0.0157 (8)	0.0203 (9)	-0.0031 (6)	0.0001 (7)	-0.0007 (7)
C10	0.0203 (9)	0.0171 (8)	0.0230 (10)	-0.0046 (6)	-0.0050 (7)	0.0011 (7)
C11	0.0256 (9)	0.0255 (9)	0.0203 (10)	-0.0056 (7)	-0.0047 (7)	0.0038 (8)
C12	0.0219 (9)	0.0282 (9)	0.0192 (10)	-0.0072 (7)	0.0004 (6)	-0.0042 (8)
C13	0.0269 (9)	0.0276 (10)	0.0294 (11)	0.0031 (7)	-0.0037 (8)	0.0038 (8)
C14	0.0322 (11)	0.0547 (13)	0.0220 (11)	0.0013 (9)	0.0024 (8)	-0.0055 (9)

## Geometric parameters ( $\text{\AA}$ , $^\circ$ )

S1—C9	1.7646 (17)	C4—H4	0.9300
S1—C8	1.7947 (17)	C5—C6	1.385 (3)
Cl1—C1	1.742 (2)	C5—H5	0.9300
O1—C7	1.2252 (19)	C7—C8	1.516 (2)
N1—C7	1.351 (2)	C8—H8A	0.9700
N1—C6	1.416 (2)	C8—H8B	0.9700
N1—H1	0.874 (9)	C10—C11	1.385 (3)
N2—C9	1.327 (2)	C10—C13	1.502 (3)
N2—C12	1.348 (2)	C11—C12	1.387 (2)
N3—C9	1.341 (2)	C11—H11	0.9300
N3—C10	1.344 (2)	C12—C14	1.497 (3)
C1—C6	1.387 (2)	C13—H13A	0.9600
C1—C2	1.388 (3)	C13—H13B	0.9600
C2—C3	1.365 (3)	C13—H13C	0.9600
C2—H2	0.9300	C14—H14A	0.9600
C3—C4	1.383 (3)	C14—H14B	0.9600
C3—H3	0.9300	C14—H14C	0.9600
C4—C5	1.392 (3)		
C9—S1—C8	100.53 (8)	S1—C8—H8A	108.7
C7—N1—C6	124.06 (14)	C7—C8—H8B	108.7

C7—N1—H1	117.9 (13)	S1—C8—H8B	108.7
C6—N1—H1	117.4 (13)	H8A—C8—H8B	107.6
C9—N2—C12	115.58 (14)	N2—C9—N3	128.40 (15)
C9—N3—C10	115.01 (14)	N2—C9—S1	118.89 (12)
C6—C1—C2	121.14 (18)	N3—C9—S1	112.71 (12)
C6—C1—C11	119.72 (14)	N3—C10—C11	121.67 (15)
C2—C1—C11	119.13 (16)	N3—C10—C13	116.00 (15)
C3—C2—C1	119.6 (2)	C11—C10—C13	122.32 (16)
C3—C2—H2	120.2	C10—C11—C12	118.23 (16)
C1—C2—H2	120.2	C10—C11—H11	120.9
C2—C3—C4	120.55 (19)	C12—C11—H11	120.9
C2—C3—H3	119.7	N2—C12—C11	121.10 (16)
C4—C3—H3	119.7	N2—C12—C14	116.10 (16)
C3—C4—C5	119.7 (2)	C11—C12—C14	122.79 (17)
C3—C4—H4	120.2	C10—C13—H13A	109.5
C5—C4—H4	120.2	C10—C13—H13B	109.5
C6—C5—C4	120.50 (19)	H13A—C13—H13B	109.5
C6—C5—H5	119.8	C10—C13—H13C	109.5
C4—C5—H5	119.8	H13A—C13—H13C	109.5
C5—C6—C1	118.53 (16)	H13B—C13—H13C	109.5
C5—C6—N1	121.47 (16)	C12—C14—H14A	109.5
C1—C6—N1	120.00 (16)	C12—C14—H14B	109.5
O1—C7—N1	123.63 (14)	H14A—C14—H14B	109.5
O1—C7—C8	123.26 (14)	C12—C14—H14C	109.5
N1—C7—C8	113.10 (14)	H14A—C14—H14C	109.5
C7—C8—S1	114.09 (12)	H14B—C14—H14C	109.5
C7—C8—H8A	108.7		
C6—C1—C2—C3	1.2 (3)	N1—C7—C8—S1	171.73 (12)
C11—C1—C2—C3	-178.03 (15)	C9—S1—C8—C7	-68.05 (14)
C1—C2—C3—C4	-0.8 (3)	C12—N2—C9—N3	-0.4 (3)
C2—C3—C4—C5	-0.3 (3)	C12—N2—C9—S1	178.49 (12)
C3—C4—C5—C6	1.1 (3)	C10—N3—C9—N2	0.4 (2)
C4—C5—C6—C1	-0.7 (3)	C10—N3—C9—S1	-178.57 (11)
C4—C5—C6—N1	179.97 (16)	C8—S1—C9—N2	0.91 (15)
C2—C1—C6—C5	-0.4 (3)	C8—S1—C9—N3	179.98 (11)
C11—C1—C6—C5	178.80 (13)	C9—N3—C10—C11	0.4 (2)
C2—C1—C6—N1	178.91 (16)	C9—N3—C10—C13	-178.32 (14)
C11—C1—C6—N1	-1.9 (2)	N3—C10—C11—C12	-1.0 (2)
C7—N1—C6—C5	-48.9 (2)	C13—C10—C11—C12	177.59 (16)
C7—N1—C6—C1	131.82 (18)	C9—N2—C12—C11	-0.3 (2)
C6—N1—C7—O1	3.2 (3)	C9—N2—C12—C14	-179.39 (16)
C6—N1—C7—C8	-177.61 (15)	C10—C11—C12—N2	1.0 (2)
O1—C7—C8—S1	-9.1 (2)	C10—C11—C12—C14	179.99 (17)

Hydrogen-bond geometry ( $\text{\AA}$ ,  $^\circ$ )

$D-H\cdots A$	$D-H$	$H\cdots A$	$D\cdots A$	$D-H\cdots A$
$N1-H1\cdots O1^i$	0.873 (11)	2.054 (12)	2.8414 (18)	149.6 (18)

## supplementary materials

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C2—H2···O1 <sup>ii</sup>	0.93	2.46	3.213 (2)	138
C8—H8A···Cg1 <sup>i</sup>	0.97	2.92	3.832 (2)	157
C13—H13B···Cg1 <sup>iii</sup>	0.96	2.99	3.592 (2)	122

Symmetry codes: (i)  $x, y+1, z$ ; (ii)  $-x+1, -y+2, z+1/2$ ; (iii)  $x, y-1, z$ .



Fig. 1

