

***N*-Allyl-*N*-(2-nitrobenzenesulfonyl)-*L*-leucine methyl ester****Laurent F. Bornaghi, Sally-Ann Poulsen and Peter C. Healy\***

School of Science, Griffith University, Nathan, Brisbane 4111, Australia

Correspondence e-mail: p.healy@griffith.edu.au

**Key indicators**

Single-crystal X-ray study

 $T = 295\text{ K}$ Mean  $\sigma(\text{C}-\text{C}) = 0.007\text{ \AA}$  $R$  factor = 0.040 $wR$  factor = 0.120

Data-to-parameter ratio = 10.4

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

The structure of the title compound,  $\text{C}_{16}\text{H}_{22}\text{N}_2\text{O}_6\text{S}$ , has been determined as part of an ongoing investigation into the preparation of *N*-alkylated amino acid precursors for alkene cross-metathesis reactions for the generation of dynamic combinatorial libraries. The overall molecular conformation is stabilized by intramolecular  $\text{C}-\text{H}\cdots\text{O}$  interactions.

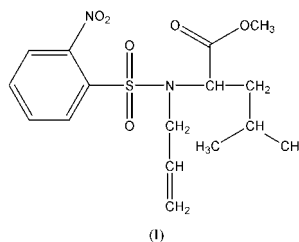
Received 5 February 2004

Accepted 10 February 2004

Online 20 February 2004

**Comment**

As part of our interest in the development of dynamic combinatorial libraries (Cousins *et al.*, 1999; Ramstrom & Lehn, 2000; Bunyapaiboonsri *et al.*, 2001; Lehn & Eliseev, 2001), we have synthesized a range of *N*-allyl-substituted amino acids as precursors for cross-metathesis of amino acids using Grubbs catalysts (Fürstner, 2000; Cannon & Blechert, 2003). In this approach, the 2-nitrobenzenesulfonyl group (oNBS) is introduced prior to allylation in order to, firstly, protect the nitrogen, and secondly, increase the acidity of the NH proton such that the amide becomes more susceptible to allylation. We have previously reported the structure of *N*-allyl-*N*-(2-nitrobenzenesulfonyl)-*L*-phenylalanine methyl ester (Poulsen *et al.*, 2003). In the present communication, we report the structure of the related compound *N*-allyl-*N*-(2-nitrobenzenesulfonyl)-*L*-leucine methyl ester, (I).



The molecules of (I) are separated by normal van der Waals distances, with bond lengths in accord with conventional values (Allen *et al.*, 1987) (Table 1). The conformational structure of (I) (Fig. 1) is very similar to that of the phenylalanine analog, with the shape determined by a number of intramolecular  $\text{C}-\text{H}\cdots\text{O}$  interactions (Table 2) and the 'spiralling' of the 2-nitrobenzenesulfonyl group above the plane of the carboxylate group to bring nitro atom O2 into close proximity to  $\alpha$  atom C7.

**Experimental**

Similar to the *L*-phenylalanine analog, (I) was prepared in accord with published procedures (Reichwein & Liskamp, 2000). To a solution of 2-nitrobenzenesulfonyl-*L*-leucine methyl ester (9.09 g, 27.5 mmol) were added  $\text{K}_2\text{CO}_3$  (7.6 g, 55 mmol) and allyl bromide (3.65 ml, 42 mmol) in anhydrous DMF (120 ml). The reaction mixture was stirred at room temperature for 18 h. Water (200 ml) was added

and the mixture was extracted with diethyl ether (3 × 150 ml). The combined extracts were washed with brine (2 × 200 ml) and dried over MgSO<sub>4</sub>. The solvent was removed under reduced pressure to give an oily yellow residue. Crystals of (I) suitable for X-ray diffraction studies were obtained by crystallization from a mixture of hexane and ethyl acetate (yield 7.6 g, 83%; m.p. 342 K). <sup>1</sup>H NMR (CDCl<sub>3</sub>, 200 MHz, p.p.m.): 0.92 (*d*, 3H, *J* = 6.2 Hz, CH<sub>3</sub>), 0.99 (*d*, 3H, *J* = 6.1 Hz, CH<sub>3</sub>), 1.65–1.80 (*m*, 3H, γ-CH and β-CH<sub>2</sub>), 3.55 (*s*, 3H, OCH<sub>3</sub>), 3.80–3.92 (*m*, 1H, NCH of NCH<sub>2</sub>), 4.11–4.22 (*m*, 1H, NCH of NCH<sub>2</sub>), 4.69–4.77 (*m*, 1H, α-CH), 5.11–5.26 (*m*, 2H, =CH<sub>2</sub>), 5.87–6.07 (*m*, 1H, =CH), 7.57–7.72 (*m*, 3H, ArH), 8.02–8.10 (*m*, 1H, ArH). <sup>13</sup>C NMR (CDCl<sub>3</sub>, 50 MHz, p.p.m.): 21.4 and 22.9 (CH<sub>3</sub>), 24.4 (γ-CH), 39.1 (β-CH<sub>2</sub>), 49.3 (NCH<sub>2</sub>), 52.4 (α-CH), 59.2 (OCH<sub>3</sub>), 117.8 (=CH<sub>2</sub>), 124.2, 131.4, 131.6, 133.2, 133.7, 135.6 and 148.3 (CH from Ar and =CH), 172.0 (CO). MS (LRMSES): *m/z* 371.1 [*M* + H]<sup>+</sup>, 393.1 [*M* + Na]<sup>+</sup>.

#### Crystal data

|   |   |
|---|---|
| C <sub>16</sub> H <sub>22</sub> N <sub>2</sub> O <sub>6</sub> S | <i>D<sub>x</sub></i> = 1.288 Mg m <sup>-3</sup> |
| <i>M<sub>r</sub></i> = 370.43                                   | Mo Kα radiation                                 |
| Monoclinic, C2  | Cell parameters from 25 reflections             |
| <i>a</i> = 15.7515 (15) Å                                       | <i>θ</i> = 12.9–16.9°                           |
| <i>b</i> = 8.2452 (17) Å  | <i>μ</i> = 0.20 mm <sup>-1</sup>                |
| <i>c</i> = 15.673 (2) Å   | <i>T</i> = 295 K                                |
| <i>β</i> = 110.153 (9)°   | Prism, colorless                                |
| <i>V</i> = 1910.9 (5) Å <sup>3</sup>                            | 0.35 × 0.30 × 0.20 mm                           |
| <i>Z</i> = 4  |   |

#### Data collection

|   |                                 |
|---|---------------------------------|
| Rigaku AFC-7R diffractometer                    | <i>θ</i> <sub>max</sub> = 27.5° |
| <i>ω</i> -2 <i>θ</i> scans                      | <i>h</i> = -8 → 20              |
| Absorption correction: none                     | <i>k</i> = 0 → 10               |
| 2590 measured reflections                       | <i>l</i> = -20 → 19             |
| 2353 independent reflections                    | 3 standard reflections          |
| 1634 reflections with <i>I</i> > 2σ( <i>I</i> ) | every 150 reflections           |
| <i>R</i> <sub>int</sub> = 0.025                 | intensity decay: 1.4%           |

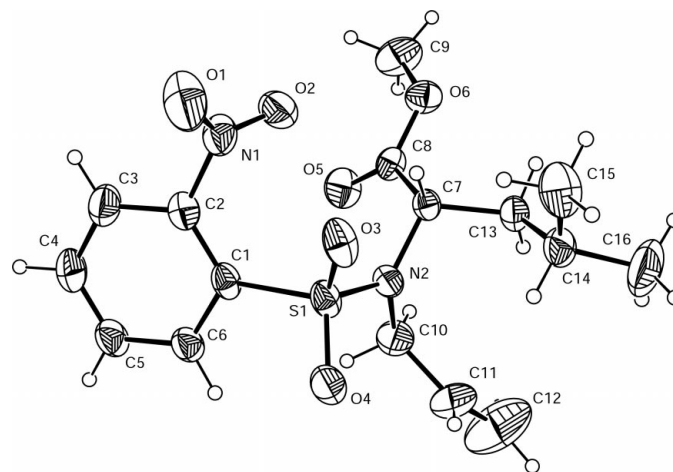
#### Refinement

|   |  |
|---|--|
| Refinement on <i>F</i> <sup>2</sup>                                     | <i>w</i> = 1/[σ <sup>2</sup> ( <i>F<sub>o</sub></i> <sup>2</sup> ) + (0.0613 <i>P</i> ) <sup>2</sup> + 0.3996 <i>P</i> ] |
| <i>R</i> [ <i>F</i> <sup>2</sup> > 2σ( <i>F</i> <sup>2</sup> )] = 0.040 | where <i>P</i> = ( <i>F<sub>o</sub></i> <sup>2</sup> + 2 <i>F<sub>c</sub></i> <sup>2</sup> )/3                           |
| <i>wR</i> ( <i>F</i> <sup>2</sup> ) = 0.120                             | (Δ/σ) <sub>max</sub> = 0.009   |
| <i>S</i> = 1.02   | Δρ <sub>max</sub> = 0.16 e Å <sup>-3</sup>   |
| 2353 reflections  | Δρ <sub>min</sub> = -0.21 e Å <sup>-3</sup>  |
| 226 parameters  | Absolute structure: Flack (1983);  |
| H-atom parameters constrained   | no Friedel pairs   |
|   | Flack parameter = 0.20 (12)  |

**Table 1**

Selected geometric parameters (Å, °).

|           |             |            |           |
|-----------|-------------|------------|-----------|
| S1—O3     | 1.423 (3)   | O5—C8      | 1.186 (4) |
| S1—O4     | 1.425 (3)   | O6—C8      | 1.328 (4) |
| S1—N2     | 1.610 (3)   | O6—C9      | 1.449 (6) |
| S1—C1     | 1.796 (4)   | N1—C2      | 1.479 (4) |
| O1—N1     | 1.229 (6)   | N2—C7      | 1.473 (4) |
| O2—N1     | 1.194 (5)   | N2—C10     | 1.474 (6) |
| O3—S1—O4  | 119.5 (2)   | C7—N2—C10  | 119.1 (3) |
| O3—S1—N2  | 109.19 (17) | S1—C1—C2   | 124.4 (2) |
| O3—S1—C1  | 107.32 (18) | S1—C1—C6   | 117.3 (3) |
| O4—S1—N2  | 106.6 (2)   | N1—C2—C1   | 122.9 (3) |
| O4—S1—C1  | 104.21 (17) | N1—C2—C3   | 115.3 (4) |
| N2—S1—C1  | 109.70 (18) | N2—C7—C8   | 110.2 (3) |
| C8—O6—C9  | 116.5 (3)   | N2—C7—C13  | 111.2 (3) |
| O1—N1—O2  | 124.8 (4)   | O5—C8—O6   | 124.8 (3) |
| O1—N1—C2  | 116.3 (4)   | O5—C8—C7   | 125.6 (3) |
| O2—N1—C2  | 118.9 (4)   | O6—C8—C7   | 109.6 (3) |
| S1—N2—C7  | 121.5 (2)   | N2—C10—C11 | 113.7 (4) |
| S1—N2—C10 | 118.7 (3)   |            |           |



**Figure 1**

View of the title compound, with the atom-numbering scheme. Displacement ellipsoids for non-H atoms are drawn at the 30% probability level.

**Table 2**

Hydrogen-bonding geometry (Å, °).

| <i>D</i> —H... <i>A</i> | <i>D</i> —H | H... <i>A</i> | <i>D</i> ... <i>A</i> | <i>D</i> —H... <i>A</i> |
|-------------------------|-------------|---------------|-----------------------|-------------------------|
| C5—H5...O5 <sup>i</sup> | 0.95        | 2.53          | 3.220 (5)             | 130                     |
| C6—H6...O4              | 0.95        | 2.46          | 2.833 (5)             | 103                     |
| C7—H7...O2              | 0.95        | 2.54          | 3.083 (5)             | 116                     |
| C7—H7...O3              | 0.95        | 2.37          | 2.894 (5)             | 114                     |
| C10—H10B...O5           | 0.95        | 2.52          | 2.986 (6)             | 110                     |
| C13—H13B...O6           | 0.95        | 2.50          | 2.862 (6)             | 103                     |

Symmetry code: (i)  $\frac{3}{2} - x, \frac{1}{2} + y, 1 - z$ .

H atoms were constrained as riding atoms, with C—H distances set at 0.95 Å. *U*<sub>iso</sub>(H) values were set at 1.2*U*<sub>eq</sub> of the parent atom.

Data collection: *MSC/AFC-7 Diffractometer Control for Windows* (Molecular Structure Corporation, 1999); cell refinement: *MSC/AFC-7 Diffractometer Control for Windows*; data reduction: *TEXSAN for Windows* (Molecular Structure Corporation, 1997–2001); program(s) used to solve structure: *TEXSAN for Windows*; program(s) used to refine structure: *TEXSAN for Windows* and *SHELXL97* (Sheldrick, 1997); molecular graphics: *PLATON* (Spek, 2002) and *ORTEP-3* (Farrugia, 1997); software used to prepare material for publication: *TEXSAN for Windows* and *PLATON*.

We acknowledge financial support of this work by Griffith University and a J. G. Russell award from the Australian Academy of Science.

#### References

- Allen, F. H., Kennard, O., Watson, D. G., Brammer, L., Orpen, A. G. & Taylor, R. (1987). *J. Chem. Soc. Perkin Trans. 2*, pp. S1–19.
- Bunyapaiboonsri, T., Ramstrom, O., Lohmann, S., Lehn, J.-M., Peng, L. & Goeldner, M. (2001). *ChemBioChem*, **2**, 438–444.
- Connon, J. & Blechert, S. (2003). *Angew. Chem. Int. Ed.* **42**, 1900–1923.
- Cousins, G. R. L., Poulsen, S.-A. & Sanders J. K. M. (1999). *Chem. Commun.* pp. 1575–1576.
- Farrugia, L. J. (1997). *J. Appl. Cryst.* **30**, 565.
- Flack, H. D. (1983). *Acta Cryst.* **A39**, 876–881.
- Füerstner, A. (2000). *Angew. Chem. Int. Ed.* **39**, 3012–3043.
- Lehn, J.-M. & Eliseev, A. V. (2001). *Science*, **291**, 2331–2332.
- Molecular Structure Corporation (1997–2001). *TEXSAN for Windows*. Version 1.06. MSC, 9009 New Trails Drive, The Woodlands, TX 77381, USA.

- Molecular Structure Corporation (1999). *MSC/AFC-7 Diffractometer Control for Windows*. Version 1.02. MSC, 9009 New Trails Drive, The Woodlands, TX 77381, USA.
- Poulsen, S.-A., Cassandra, N. & Healy, P. C. (2003). *Acta Cryst.* **E59**, o967–o968.
- Ramstrom, O. & Lehn, J.-M. (2000). *ChemBioChem*, **1**, 41–48.
- Reichwein, J. F. & Liskamp, R. M. J. (2000). *Eur. J. Org. Chem.* **12**, 2335–2344.
- Sheldrick, G. M. *SHELXL97*. (1997). University of Göttingen, Germany.
- Spek, A. L. (2002). *PLATON*. University of Utrecht, The Netherlands.