

# Methyl 2-benzamido-4-(3,4-dimethoxyphenyl)-5-methylbenzoate and *N*-{5-benzoyl-2-[(*Z*)-2-methoxyethenyl]-4-methylphenyl}benzamide

Krištof Kranjc, Marijan Kočevar and Franc Perdih\*

Faculty of Chemistry and Chemical Technology, University of Ljubljana, Aškerčeva 5, PO Box 537, SI-1000 Ljubljana, Slovenia  
Correspondence e-mail: franc.perdih@fktk.uni-lj.si

Received 17 February 2011

Accepted 26 April 2011

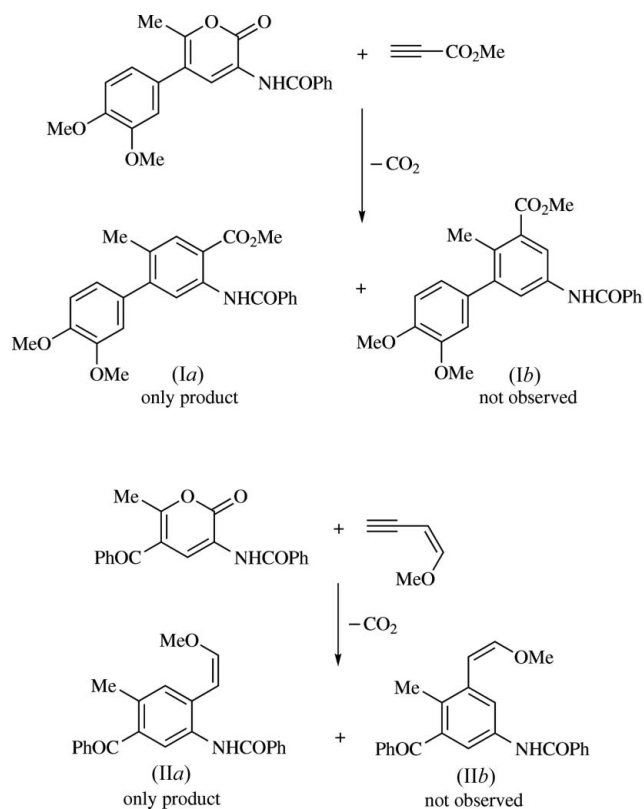
Online 10 May 2011

Methyl 2-benzamido-4-(3,4-dimethoxyphenyl)-5-methylbenzoate,  $C_{24}H_{23}NO_5$ , (*Ia*), and *N*-{5-benzoyl-2-[(*Z*)-2-methoxyethenyl]-4-methylphenyl}benzamide,  $C_{24}H_{21}NO_3$ , (*IIa*), were formed *via* a Diels–Alder reaction of appropriately substituted 2*H*-pyran-2-ones and methyl propiolate or (*Z*)-1-methoxybut-1-en-3-yne, respectively. Each of these cycloadditions might yield two different regioisomers, but just one was obtained in each case. In (*Ia*), an intramolecular N–H···O hydrogen bond closes a six-membered ring. A chain is formed due to aromatic  $\pi$ – $\pi$  interactions, and a three-dimensional framework structure is formed by a combination of C–H···O and C–H··· $\pi$ (arene) hydrogen bonds. Compound (*IIa*) was formed not only regioselectively but also chemoselectively, with just the triple bond reacting and the double bond remaining unchanged. Compound (*IIa*) crystallizes as N–H···O hydrogen-bonded dimers stabilized by aromatic  $\pi$ – $\pi$  interactions. Dimers of (*IIa*) are connected into a chain by weak C–H··· $\pi$ (arene) interactions.

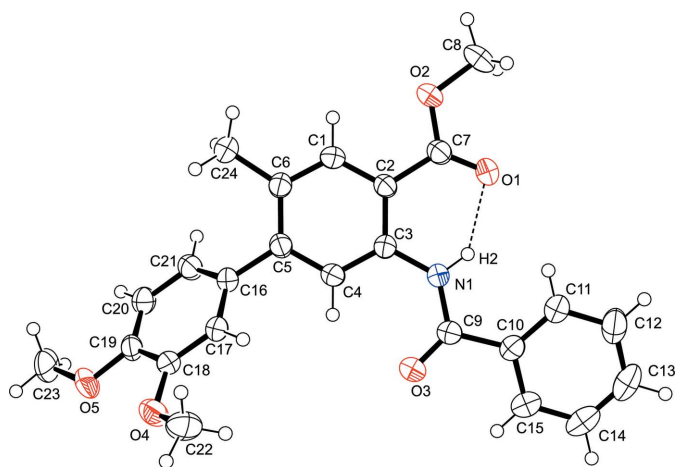
## Comment

The Diels–Alder reaction is one of the most important synthetic tools for the construction of new C–C bonds (Nicolaou *et al.*, 2002). 2*H*-Pyran-2-ones are useful dienes for such transformations (Afarinkia *et al.*, 1992; Woodard & Posner, 1999). During our research we have already investigated a set of Diels–Alder reactions between substituted 2*H*-pyran-2-ones as dienes and various alkynes as dienophiles (Kranjc *et al.*, 2004). As an intermediate, an oxabicyclo[2.2.2]octadiene system is formed in this reaction, but it has not been isolated so far. This intermediate must therefore be spontaneously transformed into the final benzamide product *via* elimination of CO<sub>2</sub> with a retro-Diels–Alder reaction. In the two cases presented here, we have been studying the regioselectivity of these reactions, whereby there are two possible ways that the dienophile can attack the diene.

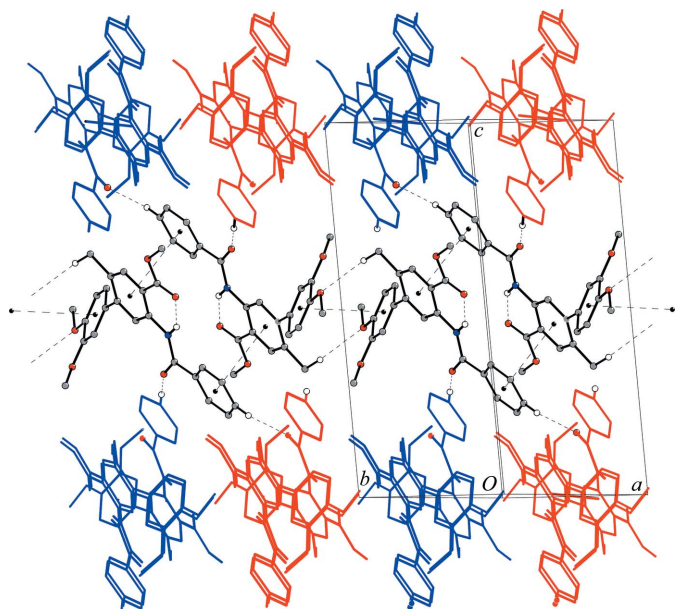
In the case of (*I*), the dienophile was methyl propiolate and its cycloaddition could yield either (*Ia*) or (*Ib*) (see reaction scheme; Kranjc & Kočevar, 2005). On the basis of <sup>1</sup>H NMR spectroscopy it was determined that just one product was obtained. In order to determine the regioselectivity of the Diels–Alder reaction, the single-crystal X-ray diffraction analysis of (*I*) was performed and showed that the correct structure was (*Ia*). In the second case, we used (*Z*)-1-methoxybut-1-en-3-yne as the dienophile (Kranjc & Kočevar, 2008). Here, besides the regioselectivity as in the case of (*I*), the chemoselectivity was also important, *i.e.* whether the triple bond of the dienophile would react preferentially over the double bond. As in the previous case, the Diels–Alder reaction gave just one type of product, (*IIa*). Single-crystal X-ray diffraction analysis showed that the triple bond has reacted exclusively and the double bond in (*IIa*) retains the *Z* orientation.



In the crystal structure of (*Ia*), there is an intramolecular hydrogen bond between the amide N1–H2 group and the carbonyl O1 atom from the neighbouring acetyl group, with graph-set motif *S*(6) (Bernstein *et al.*, 1995) (Fig. 1 and Table 1). The acetyl and amide units deviate slightly from coplanarity with the C1–C6 benzene ring, with torsion angles C3–C2–C7–O1 = 3.5 (3)° and C9–N1–C3–C4 = –11.2 (3)°. Such coplanarity is common when the amide unit is involved in intramolecular hydrogen bonding and is also observed in, for example, methyl 2-[(methoxyacetyl)amino]benzoate (Liu *et al.*, 2006), methyl 2-(2-hydroxyacetamido)benzoate (Alam *et al.*, 2010) and diethyl 2-amino-5-[(2-

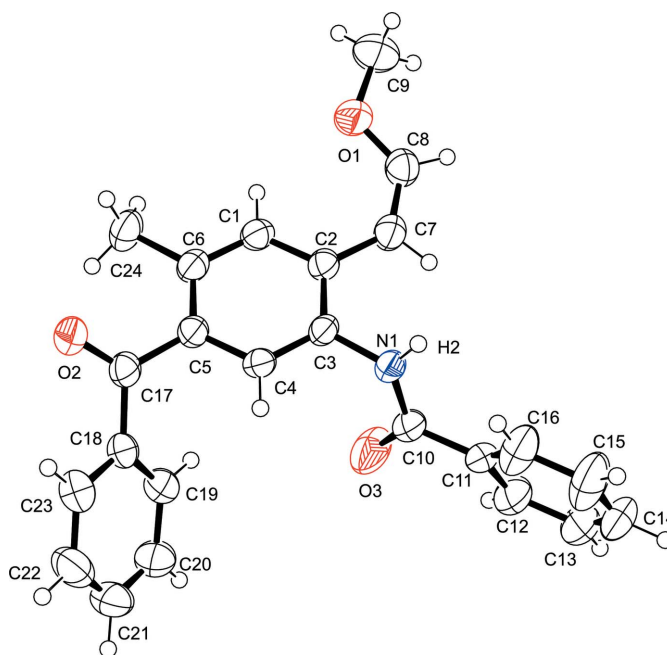


**Figure 1**  
The molecular structure of (*Ia*), showing the atom-labelling scheme. Displacement ellipsoids are drawn at the 50% probability level. The intramolecular hydrogen bond is indicated by a dashed line.



**Figure 2**  
A packing diagram for (*Ia*). Dashed lines indicate  $\pi$ - $\pi$  interactions and hydrogen bonds. Chains running parallel above and below are indicated by arbitrary colours (blue and red in the electronic version of the journal) for clarity. Also for the sake of clarity, H atoms not involved in the motif shown have been omitted.

methoxybenzoyl)amino]terephthalate (Wu *et al.*, 2004). It might thus be expected that larger deviations from planarity might disable the intramolecular hydrogen bonding. However, there are interesting examples in the literature, such as methyl 2-[[2-([2-(*tert*-butoxycarbonyl)amino]benzoyl)amino]-2-methylpropanoyl]amino]benzoate (Prabhakaran *et al.*, 2008), where intramolecular hydrogen bonding is present, even though the aminocarbonyl and *tert*-butoxycarbonylamino groups are twisted out of the plane by 28.5 and 17.9°, respectively. An even larger twist of 59.4° is found in ethyl 2-([3-bromo-1-(3-chloropyridin-2-yl)-1*H*-pyrazol-5-yl]carbonyl)amino]-5-chloro-3-methylbenzoate (Dong *et al.*, 2009) due to steric interference



**Figure 3**  
The molecular structure of (*IIa*), showing the atom-labelling scheme. Displacement ellipsoids are drawn at the 50% probability level.

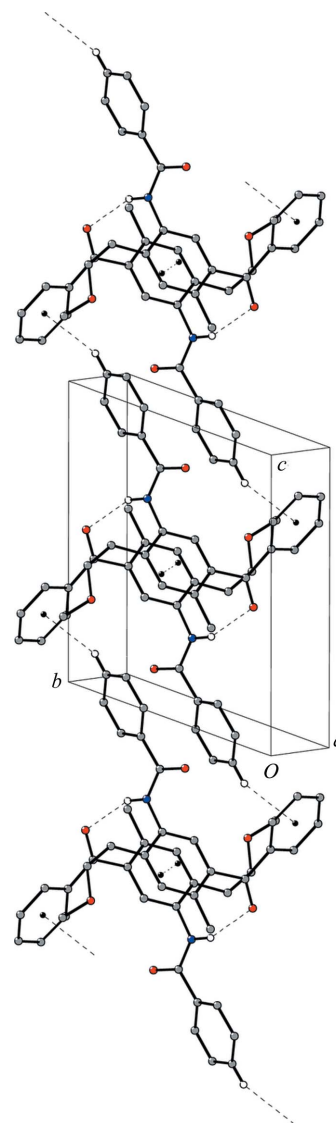
caused by the methyl substituent at the *ortho* position to the amide group, but intramolecular hydrogen bonding is, surprisingly, still preserved. These examples show that one cannot predict solely from the twist angle whether intra- or intermolecular hydrogen bonding will occur.

The orientations of all three aromatic rings in (*Ia*) are influenced by their ability to form  $\pi$ - $\pi$  interactions. Benzene rings C1–C6 (centroid *Cg*1) and C10–C15 (centroid *Cg*2) are involved in  $\pi$ - $\pi$  interactions, with a *Cg*1...*Cg*2(1 - *x*, -*y*, -*z*) centroid-centroid distance of 3.9171 (10) Å, a dihedral angle between the rings of 8.68 (8)°, a perpendicular distance from centroid *Cg*1 to the plane of the C10–C15 ring of 3.507 Å, and an angle between the intercentroid vector and the normal to the second ring of 26.45° (see Fig. 2). The planes of benzene rings C1–C6 and C16–C21 (centroid *Cg*3) are twisted by 49.43 (7)° and therefore enable a  $\pi$ - $\pi$  interaction between two parallel C16–C21 rings, with a *Cg*3...*Cg*3(2 - *x*, 1 - *y*, -*z*) centroid-centroid distance of 3.9646 (9) Å, a perpendicular distance from the centroid *Cg*3 to the plane of the other ring of 3.6313 (6) Å and a slippage between the centroids of 1.591 Å. These interactions are consistent with well defined  $\pi$ - $\pi$  stacking interactions (Hunter & Sanders, 1990; Choudhury & Chitra, 2010), although the interplanar separations are somewhat greater than the graphite spacing of 3.35 Å (Bacon, 1951). According to Janiak (2000), these interactions can be regarded as medium strong, since strong interactions exhibit rather short centroid-centroid contacts (*Cg*...*Cg* < 3.8 Å), small slip angles (<25°) and vertical displacements (<1.5 Å), which translate into a sizeable overlap of the aromatic planes. In comparison, medium-to-weak interactions exhibit rather long centroid-centroid distances (>4.0 Å) together with large slip angles (>30°) and vertical displacements (>2.0 Å) (Janiak,

2000; Yang *et al.*, 2005; Dorn *et al.*, 2005). A chain is formed due to these  $\pi$ - $\pi$  interactions and the supramolecular aggregation is controlled by a combination of  $C13-H13 \cdots O3(1-x, -\frac{1}{2}+y, \frac{1}{2}-z)$  hydrogen bonding between the phenyl ring of the benzoylamine group and the carbonyl atom of the amide group, and  $C24-H24B \cdots O5(-x, 2-y, 1-z)$  hydrogen bonds between the methyl and one of the methoxy groups (Fig. 2 and Table 1).

In contrast with (Ia), where the amide group has a suitable hydrogen-bond acceptor in the *ortho* position, compound (IIa) has the closest suitable hydrogen-bond acceptor at the *meta* position and hence, due to this large separation, an intramolecular interaction is not possible (Fig. 3). Indeed, the crystal structure of (IIa) contains centrosymmetric hydrogen-bonded dimers facilitated by  $N1-H2 \cdots O2(-x, 1-y, 1-z)$  interactions involving the amide and benzoyl groups of adjacent molecules. The dimers can be described by the graph-set motif  $R_2^2(14)$  (Table 2). This dimeric structure is further stabilized by a medium-strong  $\pi$ - $\pi$  interaction between two parallel C1-C6 rings (centroid Cg1) of two adjacent molecules, with a  $Cg1 \cdots Cg1(-x, 1-y, 1-z)$  centroid-to-centroid distance of 3.8081 (13) Å, a perpendicular distance from the centroid of one ring to the plane of the other of 3.4212 (8) Å and a slippage between the centroids of 1.672 Å (Fig. 4). Intermolecular hydrogen bonding is associated with a large twist of the benzamide and benzoyl groups out of the C1-C6 plane, with torsion angles  $C10-N1-C3-C4 = 70.6(3)^\circ$  and  $C6-C5-C17-O2 = -37.5(3)^\circ$ . We found no similar sandwich-like dimers with a benzamide group. Dimers with nearly coplanar molecules are present in 3-(acetylamino)benzoic acid (Hansen *et al.*, 2007) and are further hydrogen bonded *via* the carboxyl group. The vast majority of compounds containing a benzamide group form infinite hydrogen-bonded chains or layers. There is great variability in the observed twist angles between the planes of the benzene ring and the benzamide group in the known examples, with values up to  $60^\circ$  (see, for example, Adams *et al.*, 2001; Nimmanpipug *et al.*, 2002; Saeed *et al.*, 2009).

Compound (IIa) has an additional ethenyl group with preserved *Z* geometry around the double bond. This ethenyl group is conjugated with the C1-C6 benzene ring but deviates from coplanarity by  $16.19(15)^\circ$ . In the related compounds (*Z*)-3-(3,4-dimethoxyphenyl)-2-(2-methoxyphenoxy)-2-propenoic acid (Langer *et al.*, 2004) and trichloro(pentamethylcyclopentadienyl)(tetrahydrofuran)(*p*-tolylethenoxy)tantalum (Meyer *et al.*, 1990), somewhat smaller deviations of 0.15 and  $6.7^\circ$ , respectively, were observed. Larger deviations in the range  $20$ – $25.9^\circ$  can be found in, for example, (*Z*)-1-chloro-2-(*p*-tolyl)ethenyl benzoate (Bejot *et al.*, 2005) and 2-phenyl-1-(1-acetoxy-2-phenylethenyl)cyclopropane (Miki *et al.*, 2003). Even larger deviations from planarity would disable the conjugation of the ethenyl group with the benzene ring, as observed in methyl (*2E*)-(4-methoxyphenyl)(1,3-oxazolidin-2-ylidene)ethanoate (Beccalli *et al.*, 1997) and (*E*)-methyl 2-[2-(6-chloropyrimidin-4-yloxy)phenyl]-3-methoxyacrylate (Ma *et al.*, 2007), with torsion angles of  $48.7$  and  $71.6^\circ$ , respectively. In both cases, the large torsion angles are caused by the presence



**Figure 4**

A packing diagram for (IIa). Dashed lines indicate  $\pi$ - $\pi$  interactions and hydrogen bonds. For the sake of clarity, H atoms not involved in the motif shown have been omitted.

of sterically demanding groups, either on the ethenyl group, as in the former compound, or on the benzene ring in the *ortho* position to the ethenyl group, as in the latter case.

Dimers of (IIa) are connected into a chain by weak  $C14-H14 \cdots Cg3(-x, 1-y, -z)$  interactions ( $Cg3$  is the centroid of the C18-C23 ring) (Fig. 4 and Table 2). These interactions have an influence on the  $O2-C17-C18-C23$  torsion angle, which is  $-28.3(3)^\circ$ , leading to a twist of  $61.22(12)^\circ$  between the planes of benzene rings C1-C6 and C18-C23. No additional  $\pi$ - $\pi$  interactions were found in the crystal structure of (IIa).

## Experimental

For the preparation of (Ia) (Kranjc & Kočevar, 2005), a mixture of *N*-[5-(3,4-dimethoxyphenyl)-6-methyl-2-oxo-2*H*-pyran-3-yl]benzamide (365 mg, 1 mmol) and methyl propiolate (168 mg, 2 mmol) in xylene (3 ml) was heated under reflux for 16.5 h. The volatile

components were removed under reduced pressure and the residue was treated with cold methanol (2–3 ml). The precipitated material was filtered off, washed with cold methanol (1–2 ml) and recrystallized from methanol (m.p. 458.5–461 K).

For the preparation of (IIa) (Kranjc & Kočevar, 2008), a mixture of *N*-(5-benzoyl-6-methyl-2-oxo-2*H*-pyran-3-yl)benzamide (667 mg, 2 mmol) and (*Z*)-1-methoxybut-1-en-3-yne (50% solution in MeOH) (656 mg, 8 mmol) in toluene (3 ml) was irradiated in a closed vial in a focused microwave apparatus (Discover by CEM, Matthews, North Carolina, USA) for 45 min. The final temperature was set at 423 K, the power at 120 W and the ramp time at 5 min. The volatile components were removed under reduced pressure, and the remaining solid was treated with methanol (1.5 ml) and cooled. The precipitated material was filtered off, washed with cold methanol (1 ml) and recrystallized from methanol (m.p. 447–449 K).

## Compound (Ia)

### Crystal data

$C_{24}H_{23}NO_5$	$V = 2003.49 (7) \text{ \AA}^3$
$M_r = 405.43$	$Z = 4$
Monoclinic, $P2_1/c$	Mo $K\alpha$ radiation
$a = 7.6516 (1) \text{ \AA}$	$\mu = 0.09 \text{ mm}^{-1}$
$b = 14.7810 (3) \text{ \AA}$	$T = 293 \text{ K}$
$c = 17.8063 (4) \text{ \AA}$	$0.2 \times 0.2 \times 0.2 \text{ mm}$
$\beta = 95.8175 (8)^\circ$	

### Data collection

Nonius KappaCCD area-detector diffractometer	8696 measured reflections
Absorption correction: multi-scan (SCALEPACK; Otwinowski & Minor, 1997)	4566 independent reflections
$T_{\min} = 0.981$ , $T_{\max} = 0.981$	3167 reflections with $I > 2\sigma(I)$
	$R_{\text{int}} = 0.033$

### Refinement

$R[F^2 > 2\sigma(F^2)] = 0.046$	275 parameters
$wR(F^2) = 0.126$	H-atom parameters constrained
$S = 1.02$	$\Delta\rho_{\text{max}} = 0.18 \text{ e \AA}^{-3}$
4566 reflections	$\Delta\rho_{\text{min}} = -0.17 \text{ e \AA}^{-3}$

## Compound (IIa)

### Crystal data

$C_{24}H_{21}NO_3$	$\gamma = 67.753 (1)^\circ$
$M_r = 371.42$	$V = 982.60 (4) \text{ \AA}^3$
Triclinic, $P\bar{1}$	$Z = 2$
$a = 9.6722 (2) \text{ \AA}$	Mo $K\alpha$ radiation
$b = 10.0140 (2) \text{ \AA}$	$\mu = 0.08 \text{ mm}^{-1}$
$c = 11.5677 (3) \text{ \AA}$	$T = 293 \text{ K}$
$\alpha = 71.422 (1)^\circ$	$0.2 \times 0.2 \times 0.08 \text{ mm}$
$\beta = 84.479 (1)^\circ$	

### Data collection

Nonius KappaCCD area-detector diffractometer	6912 measured reflections
Absorption correction: multi-scan (SCALEPACK; Otwinowski & Minor, 1997)	4442 independent reflections
$T_{\min} = 0.984$ , $T_{\max} = 0.993$	2768 reflections with $I > 2\sigma(I)$
	$R_{\text{int}} = 0.030$

### Refinement

$R[F^2 > 2\sigma(F^2)] = 0.062$	255 parameters
$wR(F^2) = 0.155$	H-atom parameters constrained
$S = 1.03$	$\Delta\rho_{\text{max}} = 0.21 \text{ e \AA}^{-3}$
4442 reflections	$\Delta\rho_{\text{min}} = -0.20 \text{ e \AA}^{-3}$

**Table 1**

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

$D-H\cdots A$	$D-H$	$H\cdots A$	$D\cdots A$	$D-H\cdots A$
$N1-H2\cdots O1$	0.95	1.83	2.6741 (17)	146
$C13-H13\cdots O3^i$	0.93	2.53	3.450 (2)	172
$C24-H24B\cdots O5^{ii}$	0.96	2.57	3.420 (2)	148

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

**Table 2**

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

$Cg3$  is the centroid of the C18–C23 ring.

$D-H\cdots A$	$D-H$	$H\cdots A$	$D\cdots A$	$D-H\cdots A$
$N1-H2\cdots O2^i$	0.82	2.27	3.021 (2)	153
$C14-H14\cdots Cg3^{ii}$	0.93	2.99	3.820 (4)	150

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

All H atoms were initially located in difference Fourier maps. H atoms bonded to C atoms were subsequently treated as riding atoms in geometrically idealized positions, with  $C-H = 0.95$  (aromatic and alkenyl) or  $0.98 \text{ \AA}$  ( $\text{CH}_3$ ), and with  $U_{\text{iso}}(\text{H}) = kU_{\text{eq}}(\text{C})$ , where  $k = 1.5$  for methyl groups, which were permitted to rotate but not to tilt, and 1.2 for all other H atoms. H atoms bonded to N atoms were treated as riding, with  $U_{\text{iso}}(\text{H}) = 1.5U_{\text{eq}}(\text{N})$ .

For both compounds, data collection: COLLECT (Nonius, 1998); cell refinement: DENZO-SMN (Otwinowski & Minor, 1997); data reduction: DENZO-SMN; program(s) used to solve structure: SHELXS97 (Sheldrick, 2008); program(s) used to refine structure: SHELXL97 (Sheldrick, 2008); molecular graphics: ORTEP-3 (Farrugia, 1997) and DIAMOND (Brandenburg, 1999); software used to prepare material for publication: WinGX (Farrugia, 1999) and publCIF (Westrip, 2010).

The authors thank the Ministry of Higher Education, Science and Technology of the Republic of Slovenia and the Slovenian Research Agency for financial support (grant Nos. P1-0230-0103 and P1-0230-0175).

Supplementary data for this paper are available from the IUCr electronic archives (Reference: KU3044). Services for accessing these data are described at the back of the journal.

## References

- Adams, H., Bernad, P. L. Jr, Eggleston, D. S., Haltiwanger, R. C., Harris, K. D. M., Hembury, G. A., Hunter, C. A., Livingstone, D. J., Kariuki, B. M. & McCabe, J. F. (2001). *Chem. Commun.* pp. 1500–1501.
- Afarinkia, K., Vinader, V., Nelson, T. D. & Posner, G. H. (1992). *Tetrahedron*, **48**, 9111–9171.
- Alam, S., Saeed, S., Fischer, A. & Khan, N. (2010). *Acta Cryst.* **E66**, o913.
- Bacon, G. E. (1951). *Acta Cryst.* **4**, 558–561.
- Beccalli, E. M., Marchesini, A. & Pilati, T. (1997). *Tetrahedron*, **53**, 10433–10440.
- Bejot, R., Tisserand, S., Reddy, L. M., Barma, D. K., Baati, R. J., Falck, R. & Mioskowski, C. (2005). *Angew. Chem. Int. Ed.* **44**, 2008–2011.
- Bernstein, J., Davis, R. E., Shimon, L. & Chang, N.-L. (1995). *Angew. Chem. Int. Ed. Engl.* **34**, 1555–1573.
- Brandenburg, K. (1999). DIAMOND. Crystal Impact GbR, Bonn, Germany.
- Choudhury, R. R. & Chitra, R. (2010). *CrystEngComm*, **12**, 2113–2121.
- Dong, W., Xu, J., Xiong, L., Liu, X. & Li, Z. (2009). *Chin. J. Chem.* **27**, 579–586.
- Dorn, T., Janiak, C. & Shandi, A.-K. (2005). *CrystEngComm*, **7**, 633–641.
- Farrugia, L. J. (1997). *J. Appl. Cryst.* **30**, 565.

- Farrugia, L. J. (1999). *J. Appl. Cryst.* **32**, 837–838.
- Hansen, L. K., Perlovich, G. L. & Bauer-Brandl, A. (2007). *Acta Cryst.* **E63**, o2361.
- Hunter, C. A. & Sanders, J. K. M. (1990). *J. Am. Chem. Soc.* **112**, 5525–5534.
- Janiak, C. (2000). *J. Chem. Soc. Dalton Trans.* pp. 3885–3896.
- Kranjc, K. & Kočevar, M. (2005). *New J. Chem.* **29**, 1027–1034.
- Kranjc, K. & Kočevar, M. (2008). *Tetrahedron*, **64**, 45–52.
- Kranjc, K., Štefane, B., Polanc, S. & Kočevar, M. (2004). *J. Org. Chem.* **69**, 3190–3193.
- Langer, V., Li, S., Lundquist, K. & Stomberg, R. (2004). *Acta Cryst.* **E60**, o165–o167.
- Liu, Q.-X., Feng, J.-C., Yin, L.-N. & Guo, J.-H. (2006). *Acta Cryst.* **E62**, o3374–o3375.
- Ma, H.-F., Jia, H.-S., Liu, S., Wen, F. & Chen, B.-L. (2007). *Acta Cryst.* **E63**, o526–o527.
- Meyer, T. Y., Garner, L. R., Baenziger, N. C. & Messerle, L. (1990). *Inorg. Chem.* **29**, 4045–4050.
- Miki, K., Ohe, K. & Uemura, S. (2003). *J. Org. Chem.* **68**, 8505–8513.
- Nicolaou, K. C., Snyder, S. A., Montagnon, T. & Vassilikogiannakis, G. (2002). *Angew. Chem. Int. Ed.* **41**, 1668–1698.
- Nimmanpipug, P., Tashiro, K., Maeda, Y. & Rangsiman, O. (2002). *J. Phys. Chem. B*, **106**, 6842–6848.
- Nonius (1998). *COLLECT*. Nonius BV, Delft, The Netherlands.
- Otwinowski, Z. & Minor, W. (1997). *Methods in Enzymology*, Vol. 276, *Macromolecular Crystallography, Part A*, edited by C. W. Carter Jr & R. M. Sweet, pp. 307–326. New York: Academic Press.
- Prabhakaran, P., Kale, S. S., Puranik, V. G., Rajamohanam, P. R., Chetina, O., Howard, J. A. K., Hofmann, H.-J. & Sanjayan, G. J. (2008). *J. Am. Chem. Soc.* **130**, 17743–17754.
- Saeed, S., Rashid, N., Hussain, R. & Jones, P. G. (2009). *Acta Cryst.* **E65**, o2140.
- Sheldrick, G. M. (2008). *Acta Cryst.* **A64**, 112–122.
- Westrip, S. P. (2010). *J. Appl. Cryst.* **43**, 920–925.
- Woodard, B. T. & Posner, G. H. (1999). *Advances in Cycloaddition*, Vol. 5, edited by M. Harmata, pp. 47–83. Greenwich, Connecticut: JAI Press.
- Wu, Z.-Q., Jiang, X.-K., Zhu, S.-Z. & Li, Z.-T. (2004). *Org. Lett.* **6**, 229–232.
- Yang, X.-J., Drepper, F., Wu, B., Sun, W.-H., Haehnel, W. & Janiak, C. (2005). *Dalton Trans.* pp. 256–267.