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Crystal structure of dimethyl (*R*)-2-(3-(1-phenylethyl)thioureido)-[1,1′-biphenyl]-4,4′-dicarboxylate, $C_{25}H_{24}N_2O_4S$

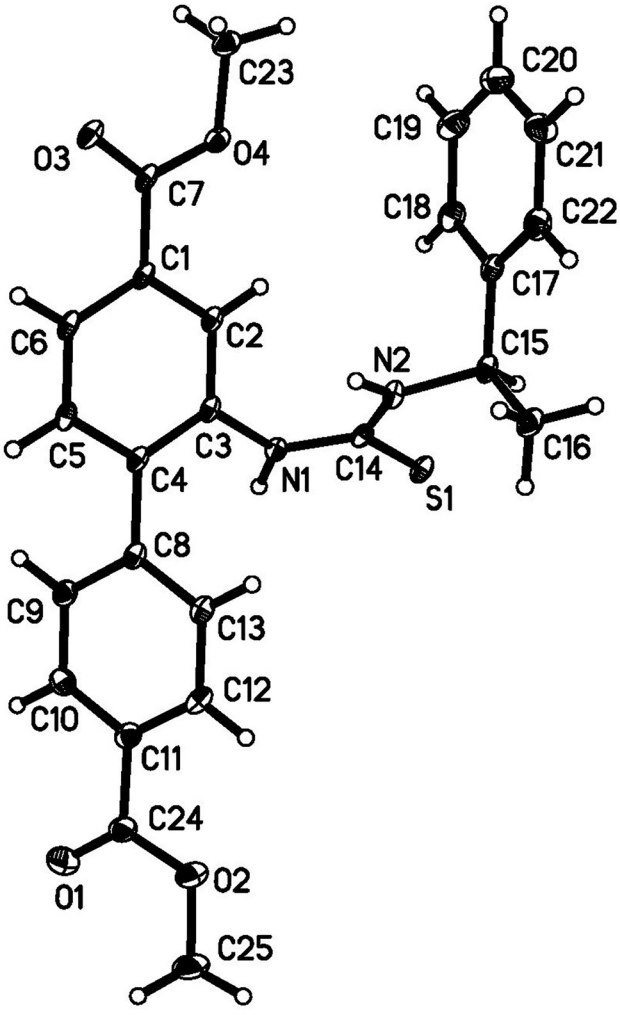

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Table 1: Data collection and handling.

Crystal:	Colourless block
Size:	0.16 × 0.13 × 0.11 mm
Wavelength:	CuKα radiation (1.54184 Å)
μ:	1.57 mm^{-1}
Diffractometer, scan mode:	SuperNova, ω
θ_{max}, completeness:	73.9°, >99 %
$N(hkl)_{measured}$, $N(hkl)_{unique}$, R_{int}:	8288, 4391, 0.064
Criterion for I_{obs}, $N(hkl)_{gt}$:	$I_{obs} > 2\ \sigma(I_{obs})$, 4162
$N(param)$refined:	293
Programs:	CrysAlis^{PRO} [1], Shelx [2, 4], Olex2 [3]

Abstract
$C_{25}H_{24}N_2O_4S$, orthorhombic, $P2_12_12_1$ (no. 19), a = 6.8049(5) Å, b = 12.2546(8) Å, c = 26.8916(18) Å, V = 2242.5(3) $Å^3$, Z = 4, $R_{gt}(F)$ = 0.0581, w$R_{ref}(F^2)$ = 0.1560, T = 100 K.

CCDC no.: 2335862

The crystal structure is shown in the figure. Table 1 contains crystallographic data and Table 2 contains the list of the atoms including atomic coordinates and displacement parameters.

1 Source of material

Dimethyl 2-amino-[1,1′-biphenyl]-4,4′-dicarboxylate was prepared following a modified literature procedure [6]. A mixture of (4-(methoxycarbonyl)phenyl)boronic acid (1.0 g, 5.5 mmol, 1.1 equiv), 4-bromo-2,6-diisopropylaniline (1.15 g, 5 mmol), palladium tetrakis(triphenylphosphine) (0.12 g, 0.1 mmol, 2 mol%), and potassium carbonate (2.3 g, 16.5 mmol, 3.3 equiv) in 40 mL of dioxane/H_2O (3/1) was stirred under nitrogen for 48 h at 95 °C. After that the mixture was cooled to room temperature, it was extracted with $CHCl_3$ and washed with H_2O. The organic layer was dried with $MgSO_4$, and the solvent was removed. The resulting crude product was purified by column chromatography using silica gel and petroleum ether/ethyl acetate

Table 2: Fractional atomic coordinates and isotropic or equivalent isotropic displacement parameters (Å^2).

Atom	*x*	*y*	*z*	U_{iso}*/U_{eq}
S1	0.57355 (15)	0.76164 (8)	0.44441 (4)	0.0226 (3)
O1	0.7224 (7)	0.8146 (4)	0.75507 (14)	0.0472 (10)
O2	0.4322 (7)	0.8491 (3)	0.71880 (13)	0.0427 (9)
O3	0.7761 (5)	0.1124 (3)	0.47781 (12)	0.0256 (7)
O4	0.7572 (4)	0.2416 (3)	0.41843 (11)	0.0233 (6)
N1	0.6712 (5)	0.5997 (3)	0.50425 (13)	0.0185 (7)
H1	0.739031	0.650545	0.519723	0.022*
N2	0.4112 (5)	0.5634 (3)	0.45226 (13)	0.0205 (7)
H2	0.403894	0.500464	0.467942	0.025*
C1	0.7559 (5)	0.2998 (3)	0.50157 (15)	0.0182 (8)
C2	0.7210 (6)	0.4067 (3)	0.48594 (15)	0.0182 (8)
H2A	0.710450	0.422151	0.451425	0.022*
C3	0.7017 (6)	0.4906 (3)	0.52024 (14)	0.0173 (8)
C4	0.7236 (6)	0.4696 (3)	0.57135 (15)	0.0179 (8)
C5	0.7690 (6)	0.3632 (4)	0.58616 (15)	0.0207 (8)
H5	0.792623	0.348709	0.620341	0.025*
C6	0.7802 (6)	0.2786 (3)	0.55232 (16)	0.0208 (8)
H6	0.804393	0.206329	0.563480	0.025*
C7	0.7652 (6)	0.2084 (4)	0.46602 (16)	0.0199 (8)
C8	0.6936 (6)	0.5552 (4)	0.60974 (15)	0.0203 (8)
C9	0.8367 (6)	0.5755 (4)	0.64587 (16)	0.0246 (9)
H9	0.955772	0.535017	0.645720	0.030*
C10	0.8052 (7)	0.6547 (4)	0.68205 (15)	0.0272 (9)
H10	0.904492	0.669527	0.705938	0.033*
C11	0.6291 (7)	0.7122 (4)	0.68344 (16)	0.0259 (10)
C12	0.4846 (7)	0.6916 (4)	0.64785 (18)	0.0268 (9)
H12	0.364092	0.730747	0.648612	0.032*
C13	0.5177 (7)	0.6136 (4)	0.61129 (17)	0.0242 (9)
H13	0.419248	0.599842	0.587040	0.029*
C14	0.5474 (6)	0.6342 (4)	0.46728 (14)	0.0197 (8)
C15	0.2719 (6)	0.5829 (4)	0.41122 (16)	0.0210 (8)
H15	0.306319	0.654241	0.395401	0.025*
C16	0.0668 (7)	0.5922 (4)	0.43213 (17)	0.0287 (9)
H16A	0.031440	0.523847	0.448808	0.043*
H16B	−0.026133	0.606374	0.405048	0.043*
H16C	0.061891	0.652346	0.456102	0.043*
C17	0.2978 (6)	0.4935 (4)	0.37234 (15)	0.0222 (9)
C18	0.4849 (7)	0.4751 (4)	0.35238 (18)	0.0303 (10)
H18	0.592132	0.519335	0.362636	0.036*
C19	0.5153 (8)	0.3924 (5)	0.3175 (2)	0.0369 (12)
H19	0.643518	0.379520	0.304869	0.044*
C20	0.3599 (9)	0.3293 (4)	0.30143 (18)	0.0363 (12)
H20	0.380720	0.273260	0.277590	0.044*
C21	0.1741 (8)	0.3480 (5)	0.32014 (19)	0.0355 (11)
H21	0.066555	0.305222	0.308878	0.043*
C22	0.1438 (7)	0.4293 (4)	0.35548 (18)	0.0299 (10)
H22	0.015342	0.441080	0.368251	0.036*
C23	0.7613 (7)	0.1567 (4)	0.38139 (17)	0.0275 (10)
H23A	0.720811	0.186828	0.349221	0.041*
H23B	0.671090	0.098129	0.391046	0.041*
H23C	0.894972	0.127509	0.378691	0.041*
C24	0.6038 (8)	0.7969 (4)	0.72255 (17)	0.0326 (11)
C25	0.3982 (12)	0.9330 (5)	0.7556 (2)	0.0553 (18)
H25A	0.266905	0.964121	0.750805	0.083*
H25B	0.497180	0.990523	0.751935	0.083*
H25C	0.407474	0.901187	0.788933	0.083*

(10/1) as the eluent. The product was obtained (1.1 g, 80.0 % yield).

Synthesis of dimethyl (*R*)-2-(3-(1-phenylethyl)thioureido)-[1,1′-biphenyl]-4,4′-dicarboxylate [7]. Thiophosgene (1.0 g, 9.0 mmol, 3.0 eq.) was added to a stirring emulsion of dimethyl 2-amino-[1,1′-biphenyl]-4,4′-dicarboxylate (0.86 g, 3.0 mmol, 1.0 eq.), 4 mL dichloromethane, and 4 mL of a saturated $NaHCO_3$ solution at 0 °C and stirred for 1 h. The reaction mixture was slowly warmed to room temperature and stirred for an additional 24 h. The two-phase mixture was added to a separation funnel and extracted three times with 20 mL ethyl acetate. The organic layers were combined and the solvent was removed under reduced pressure to quantitatively yield dimethyl 2-isothiocyanato-[1,1′-biphenyl]-4,4′-dicarboxylate which was directly used in the next step without further purification. To a solution of dimethyl 2-isothiocyanato-[1,1′-biphenyl]-4,4′-dicarboxylate and 20 mL *N*,*N*-dimethylformamide (*R*)-1-phenylethan-1-amine (0.04 g, 0.3 mmol, 1.0 eq.) was added at room temperature and stirred under nitrogen for 24 h. After the complete disappearance of the starting material 20 mL ethyl acetate was added and the organic mixture was washed three times with 10 mL H_2O, once with 10 mL brine, and dried over Na_2SO_4. The solvent was removed and the remaining solid was purified by column chromatography with (heptane/ethyl acetate) to give the target product (1.1 g 80 % yield) as white solid. Crystals were obtained by slow evaporation of an acetone solution at room temperature over a period of seven days. **Elemental analysis** – found: C, 66.88 %; H, 5.42 %; N, 6.20 %; S, 7.18 %; calculated for $C_{25}H_{24}N_2O_4S$: C, 66.95 %; H, 5.39 %; N, 6.25 %; S, 7.15 %.

2 Experimental details

Data were collected via CrysAlis^{PRO} 1.171.39.7e [1], the structure of crystal was determined by Shelxt [2] and refined by Olex2 [3] and Shelxl [4].

The absolute structure determination succeeded as the derived Flack parameter is found to be near zero with a low standard uncertainty [0.01(2) from 1665 selected quotients] using Parsons' method [5].

3 Comment

Organocatalysts are a class of chemical reaction catalysts that consist of non-metal elements and are used in a wide variety of chemical reactions [8, 9]. Among the organocatalysts, thiourea-based organocatalysts are popular due to their non-covalent catalysis. A wide variety of chiral thiourea organocatalysts are known in the literature to accelerate various synthetically useful asymmetric organic transformations such as Michael addition, amination reaction, domino AZA–Michael–Henry reaction, Mannich–type reactions, Nazarov cyclizations, Diels–Alder reaction [10–12]. Here, we report a new chiral thiourea organocatalyst.

The asymmetric unit of the title structure contains one dimethyl (*R*)-2-(3-(1-phenylethyl)thioureido)-[1,1′-biphenyl]-4,4′-dicarboxylate. In the crystal structure, bond lengths and bond angles within the molecular system are in agreement with the values reported [13]. The dihedral angle between the planes of two phenyl moieties is 55.6°. The bond lengths of C14–S1 and C14–N1 are 1.688(4) Å and 1.370(5) Å, respectively. And the bond lengths of O1–C24 and O3–C7 are 1.210(7) Å and 1.220(5) Å, respectively. As a result of the conjugation of the benzene moiety and adjacent carbon-nitrogen bond, the bond length of C3–N1 is 1.419(5) Å, which is shorter than that of typical C–N (1.47 Å). Furthermore, the bond lengths of C24–O2 and C7–O4 are 1.335(7) Å and 1.344(5) Å, respectively. The bond angle (N1–C14–N2) and (C3–N1–C14) are 116.6(4)° and 126.9(4)°, respectively.

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Conflict of interest statement: The authors declare no conflicts of interest regarding this article.

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