



Data Management at the CCDC

Amy A Sarjeant, Ph.D.

The Cambridge Crystallographic Data Centre

Cambridge UK

Piscataway NJ, USA



The Cambridge Crystallographic Data Centre

International Data Repository

Archive of crystal structure data
High quality scientific database

Scientific Software Provider

Search/analysis/visualisation tools
Scientific applications

Collaborative Research Organisation

New methodologies
Fundamental research

Employer of ~60 staff

Scientific editors
Software developers
Applications scientists

Cambridge UK

Piscataway NJ • Seattle WA



Originated in 1965

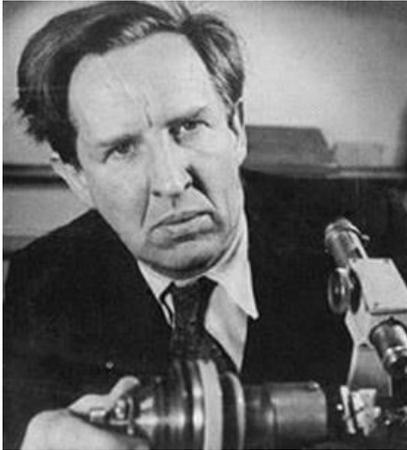
Financially self-supporting, not-for-profit

UK Registered Charity

University Partner Institute



Early Vision



J. D. Bernal



Bernal and group at Stonehenge, 1948



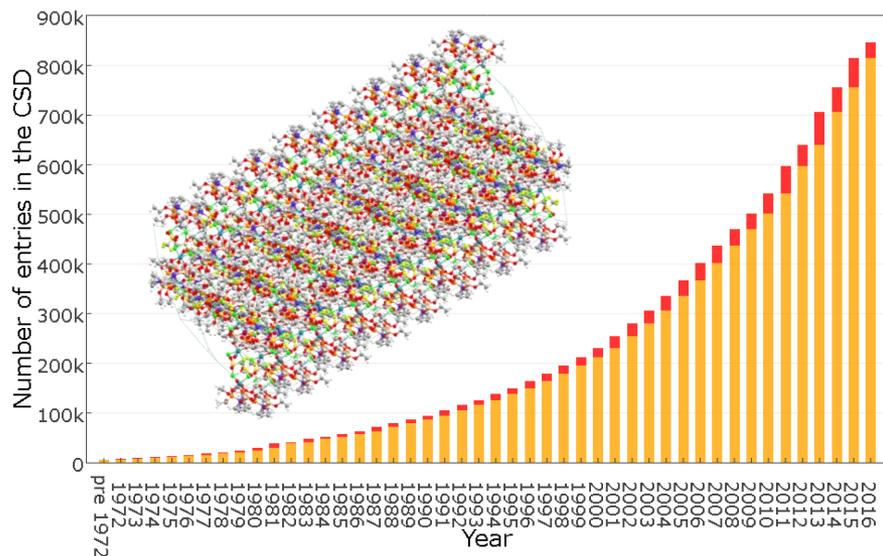
Olga Kennard

“The database was established in 1965 to fulfil a dream of myself and a great scientist, the polymath J.D. Bernal. We had a passionate belief that the **collective use of data would lead to the discovery of new knowledge** which transcends the results of individual experiments.”

Kennard, O. “From Private Data to Public Knowledge.” *The Impact of Electronic Publishing on the Academic Community*. Ed. I Butterworth. Portland Press Ltd, 1997. 159–166.



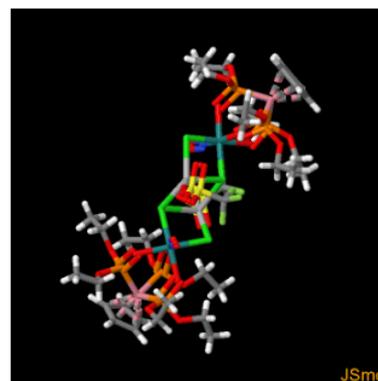
The Cambridge Structural Database



- ❑ 875,000+ small-molecule crystal structures
- ❑ Over 80,000 datasets deposited annually
- ❑ Structures available for anyone to download
- ❑ Links to over 1,000 journals
- ❑ Enriched and annotated by experts
- ❑ Access to data and knowledge
- ❑ Sustainable for over 50 years

LIMSUW : bis((μ_3 -Chloro)-(μ_2 -chloro))-hexakis(μ_2 -diethyl phosphonato)-bis((η^5 -cyclopentadienyl)-(trifluoromethanesulfonate)-(nitrosyl))-di-cobalt-di-ruthenium(ii)-di-silver
Space Group: P21/n, Cell: a 9.5821(6)Å b 36.608(2)Å c 19.0222(11)Å, α 90° β 91.1430(10)° γ 90°

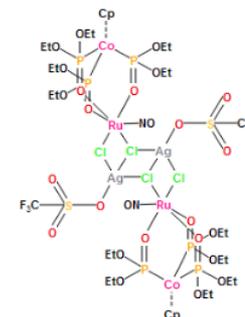
3D viewer



H Disorder Menu Open

Style Labels Packing Measure
Capped Sticks No Labels None None

Chemical diagram



View group symbols key

Additional CCDC details

CCDC Citation - Xiao-Yi Yi, T.C.H.Lam, Yiu-Keung Sau, Qian-Feng Zhang, I.D.Williams, Wa-Hung Leung, CCDC 663996: Experimental Crystal Structure Determination, 2007, DOI: [10.5517/ccq8y74](https://doi.org/10.5517/ccq8y74)
Deposited on: 15/10/2007

Associated publications

Xiao-Yi Yi, T.C.H.Lam, Yiu-Keung Sau, Qian-Feng Zhang, I.D.Williams, Wa-Hung Leung, *Inorganic Chemistry*, 2007, 46, 7193, DOI: [10.1021/ic7007683](https://doi.org/10.1021/ic7007683)



CSD deposition information

- **All depositions in CIF format are assigned CCDC numbers**
 - Deposited data freely available for all published CCDC numbers
 - Additionally published CCDC numbers that match criteria for CSD will have a corresponding curated CSD entry
- CSD includes organic and metal-organic structures from:
 - A single crystal study - where cell parameters are reported
 - A powder study - with cell parameters, atomic coordinates and constrained refinement (e.g. Rietveld)
- Organic and metal-organic also covers:
 - metal carbonyls
 - boron compounds containing one or more B-H or B-OH bond and borazines
 - ring compounds containing any two of the following elements: N, P, S, Se and Te
- The CSD also includes peptides and saccharides of up to 24 residues and mono-, di- and tri-nucleotides.

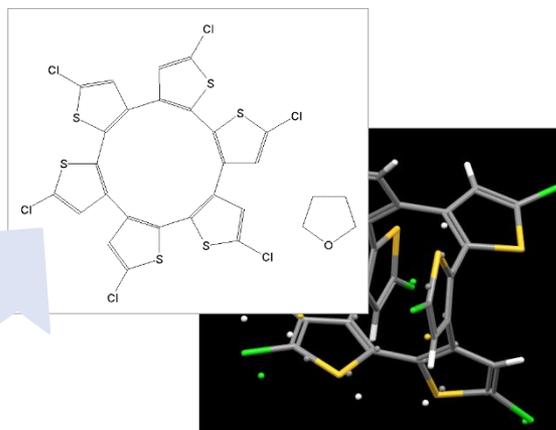


Assignment of Chemistry

```
loop_  
_atom_site_label  
_atom_site_type_symbol  
_atom_site_fract_x  
_atom_site_fract_y  
_atom_site_fract_z  
_atom_site_U_iso_or_equiv  
_atom_site_adp_type  
_atom_site_occupancy  
_atom_site_symmetry_multiplicity  
_atom_site_calc_flag  
_atom_site_refinement_flags  
_atom_site_disorder_assembly  
_atom_site_disorder_group  
C11 Cl 0.5993(2) 1.0007(7) 0.8131(17) 0.044(3) Uani 0.50 1 d PDU A 1  
S1 S 0.5321(3) 0.8260(6) 0.9322(3) 0.0327(11) Uani 0.50 1 d PDU A 1  
C2 C 0.5529(4) 0.8802(9) 0.8184(9) 0.029(4) Uani 0.50 1 d PDU A 1  
C3 C 0.5286(7) 0.8174(18) 0.7440(7) 0.031(4) Uani 0.50 1 d PDU A 1  
H3A H 0.5350 0.8343 0.6771 0.037 Uiso 0.50 1 calc PR A 1  
C4 C 0.4918(8) 0.7220(19) 0.7783(8) 0.027(4) Uani 0.50 1 d PDU A 1  
C5 C 0.4900(6) 0.7171(14) 0.8779(9) 0.029(4) Uani 0.50 1 d PDU A 1  
Cl2 Cl 0.3202(2) 0.4982(6) 1.0830(5) 0.0586(15) Uani 0.50 1 d PDU A 1  
S2 S 0.38755(19) 0.6658(5) 0.9578(5) 0.0400(10) Uani 0.50 1 d PDU A 1
```

Assignment of chemistry is required to make data findable, interoperable and reusable

- Initial automatic assignment based on knowledge in the CSD
- Reliability score from automatic assignment enables triage
- All structures ultimately reviewed by expert editorial staff

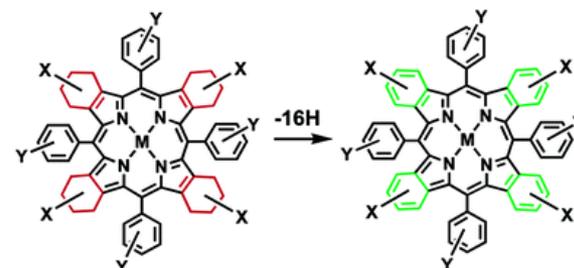
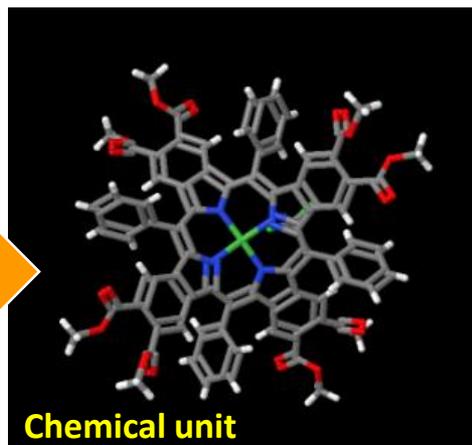
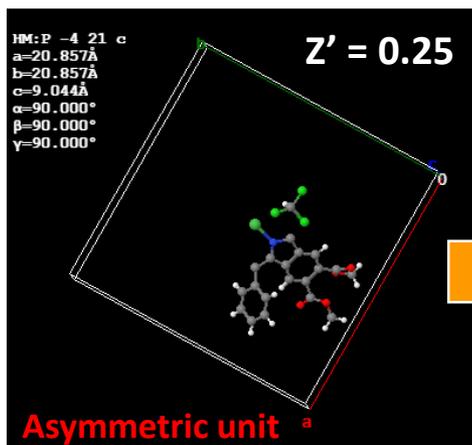


$$P(A|B) = \frac{P(B|A) P(A)}{P(B)}$$

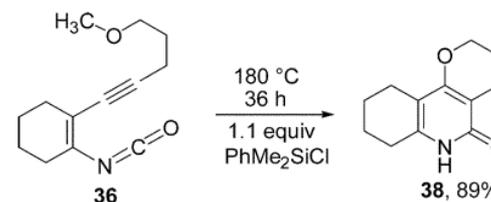
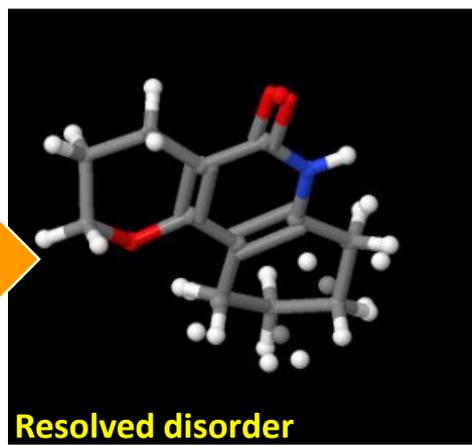
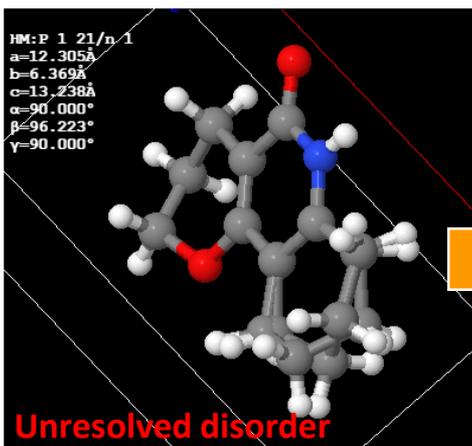




Chemical interpretation of crystallographic data



*Novel Versatile Synthesis of Substituted
Tetrabenzoporphyrins*
doi:10.1021/jo0350054



*Biradicals/Zwitterions from Thermolysis
of Enyne-Isocyanates*
doi:10.1021/jo049716t

The CSD provides a chemically meaningful representation of the structure studied



CSD Deposit - Minimising barriers & increasing incentives

The image shows a multi-step process for depositing a crystal structure to the Cambridge Crystallographic Data Centre (CCDC). It includes a registration form, an ORCID ID connection window, a 3D viewer, and a list of deposited files.

Registration Form:

- First Name(s): Suzanna
- Last Name(s): Ward
- Your email address: ward@ccdc.cam.ac.uk
- Your ORCID ID: [Empty field]
- Create or Connect your ORCID ID: [Button]
- Additional email addresses: lightfoot@ccdc.cam.ac.uk
- Institution (eg. University/Company): The CCDC
- CCDC number(s) for resubmissions: [Empty field]
- CIF/FCF/HKL/ZIP files: [Select Files...]

ORCID ID Connection Window:

Your ORCID ID

ORCID
Cambridge Crystallographic Data Centre
Deposition Portal

has asked for the following access to your ORCID Record

Read your ORCID record

Allow this permission until I revoke it.
You may revoke permissions on your account settings page. Unchecking this box will grant permission this time only.

This application will not be able to see your ORCID password, or other private info in your ORCID Record. [Privacy Policy.](#)

Sign into ORCID or Register now

Personal Account Institutional Account

Sign in with your ORCID account

3D viewer:

Pick a structure to edit

- example_2.cif
- data_tBu10kbar
- example_1.cif
- data_5_93GPa

3D viewer

Reason why your deposition does not include Structure Factor data:

Retrieve Deposited Files

- example_2_file001.cif
- example_2-data_tBu10kbar_file004.mol
- example_2-data_tBu10kbar_file003.png
- example_2-data_tBu10kbar_file002.html
- example_1_file005.cif
- example_1-data_5_93GPa_file008.mol
- example_1-data_5_93GPa_file007.png
- example_1-data_5_93GPa_file006.html

CSD Fields:

Compound name: 3-tButylsallylfaldoxime

Synonyms/other names: 3-tButylsallylfaldoxime

Crystal colour: colourless

Crystal habit: block

Crystal Data:

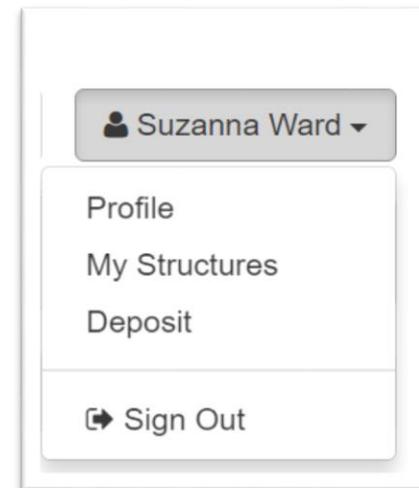
```
1 data_tBu10kbar
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
audit_creation_date 06-12-18
audit_creation_method CRYSTALS_ver_12.84
chemical_name_systematic 3-tButylsallylfaldoxime
chemical_melting_point ?
_cell_length_a 14.811(3)
_cell_length_b 6.4564(7)
_cell_length_c 19.759(4)
_cell_angle_alpha 90
_cell_angle_beta 94.060(8)
_cell_angle_gamma 90
_cell_volume 1884.7(5)
symmetry_cell_setting Monoclinic
```

>90% deposits
now made
online



A new deposition portal

- New deposition portal launched December 1st 2016
 - you can create a CCDC profile
 - log on and view and retrieve your depositions
 - deposit new data using your account



Your deposited data is now just a click away

Suzanna Ward – December 01, 2016

We are pleased to announce the launch of our new web interface to allow you to view and retrieve your deposited data.

This launch builds on our online deposition service used by over 10,000 depositors annually and provides you with a new way to log in and see your previously deposited structures.

All you need to do to access your data is [register](#) and set up your user profile. You will then be able to log on and view your datasets through 'My Structures' (<https://www.ccdc.cam.ac.uk/deposit/MyStructures>). All your deposited structures will be listed (see picture below) and searchable, with more detailed deposition information also available. You can also click through to visualise structures you have already published in our [Access Structures](#) service. Most importantly, you can check the status of any depositions and download and retrieve your datasets at any time. Registering for an account will also save you time when you have new data to deposit, as by logging in all your personal details will already be added to your deposit.

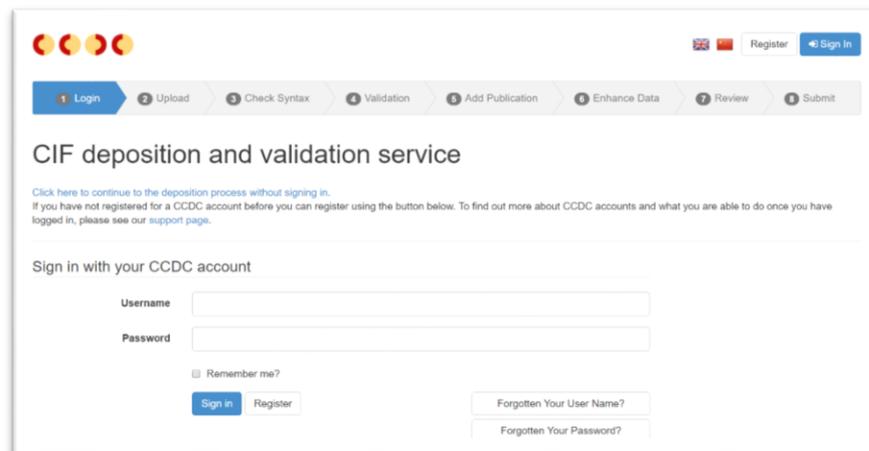
My Structures

Search for CCDC account

After depositing structures to the CCDC they may take a few minutes to appear in the table. If you are still unable to see your structures after you have received your CCDC account please contact help@ccdc.cam.ac.uk

To change the displayed columns or filter results you should click on the open arrow of the relevant column heading. To sort the results for a particular column click on the column heading you wish to sort the results by.

ID	CCDC No.	Structure	Structure ID	Author	Family	Structure	Info
141955	CCDC_141955	20150216	help@ccdc.cam.ac.uk	CCDC_141955_20150216_04_04_01	Published in the CCDC	Download	
141956	CCDC_141956	20150216	help@ccdc.cam.ac.uk	CCDC_141956_20150216_11_11_01	Published in the CCDC	Download	
141957	CCDC_141957	20150216	help@ccdc.cam.ac.uk	CCDC_141957_20150216_02_02_01	Published in the CCDC	Download	
141958	CCDC_141958	20150216	help@ccdc.cam.ac.uk	CCDC_141958_20150216_03_03_01	Published in the CCDC	Download	





My Structures

Search by CCDC Number



Clear Filters

After depositing structures to the CCDC they may take a few minutes to appear in the table. If you please contact deposit@ccdc.cam.ac.uk

To change the displayed columns or filter results you should click on the down arrow of the relevant column. To order the results by a particular column click on the column heading you wish to order your results by.

<input type="checkbox"/>	CCDC Nu...	Data block	Deposited On	Deposited By	Refcode
<input type="checkbox"/>	1416019	data_amit63m	12/01/2017	mplightfoot74@g...	AHUXUY
<input type="checkbox"/>	1416026	data_mn467	12/01/2017	mplightfoot74@g...	AHUXOS
<input type="checkbox"/>	1416025	data_l	12/01/2017	mplightfoot74@g...	AHUXIM
<input type="checkbox"/>	1416016	data_l	10/01/2017	mplightfoot74@g...	AHUXAE
<input type="checkbox"/>	926930	data_eu_dotam_...	10/01/2017	mplightfoot74@g...	
<input type="checkbox"/>	1416015	data_eu_dotam_...	10/01/2017	mplightfoot74@g...	
<input type="checkbox"/>	1416010	data_1n_DMF_1...	21/12/2016	mplightfoot74@g...	AHUWIL
<input type="checkbox"/>	1416009	data_12DMF_90K	21/12/2016	mplightfoot74@g...	AHUWEH
<input type="checkbox"/>	1416008	data_12DMF_180K	21/12/2016	mplightfoot74@g...	AHUWAD

1 2 3 4 5 6 7 8 9 10 ... 20 items per page

Download Selected 0 View 0 in Access Structures Export Clear selection

My Structure Details

Data block: l
Space Group: Pnma, Cell: a 13.167Å b 6.463Å c 8.19Å, α 90.00° β 90.00° γ 90.00°
Formula: C8 H7 Cl1 N2 O1, Temperature: 113 K

Additional CCDC Details

CCDC Number	1416025
CCDC Citation	John Smith, CCDC 1416025: Experimental Crystal Structure Determination, 2016, DOI: 10.4124/ccdc.csd.cc1jh7s
Refcode	AHUXIM
Compound Name	5-chloro-1,3-dimethyl-1H-pyrazole-4-carbaldehyde
Deposited On	12/01/2017
Deposited By	mplightfoot74@gmail.com
Additional Depositors	
Status	Published in the CSD

Associated Publications

John Smith, *Inorganic Chemistry*, 2016, 5, 5234
Created on 12/01/2017
Modified on 12/01/2017

Back to My Structures

Chemical Diagram



Source Information

File Name
invalid_2_file001.cif
File Section
data_l

Download Files View in Access Structures

Source Documents
invalid_2-data_l_file002.html

CSD Entry: AHUXIM

Your query was: CCDC Identifier(s): 1416025, Authors: John Smith and the search returned 1 record.

New Search

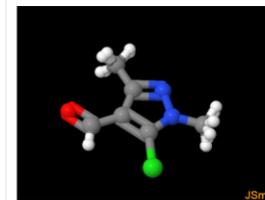
Results

<input checked="" type="checkbox"/>	Refcode	CCDC Number
<input checked="" type="checkbox"/>	AHUXIM	1416025

Download

AHUXIM : New structure undergoing enhancement
Space Group: Pnma, Cell: a 13.167(9)Å b 6.463(5)Å c 8.190(5)Å, α 90.00° β 90.00° γ 90.00°

3D viewer



H Disorder Menu Open
Style Labels Packing Measure
Ball and Stick No Labels None None

Chemical diagram



View group symbols key

Additional CCDC details

CCDC Number	1416025
CCDC Citation	John Smith CCDC 1416025: Experimental Crystal Structure Determination, 2017, DOI: 10.4124/ccdc.csd.cc1jh7s
Deposited on	12/01/2017

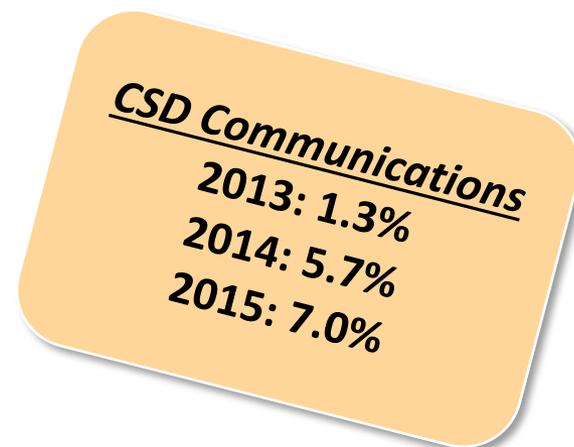
Associated publications

John Smith, *Inorganic Chemistry*, 2016, 5, 5234



Changing Data Publication Habits

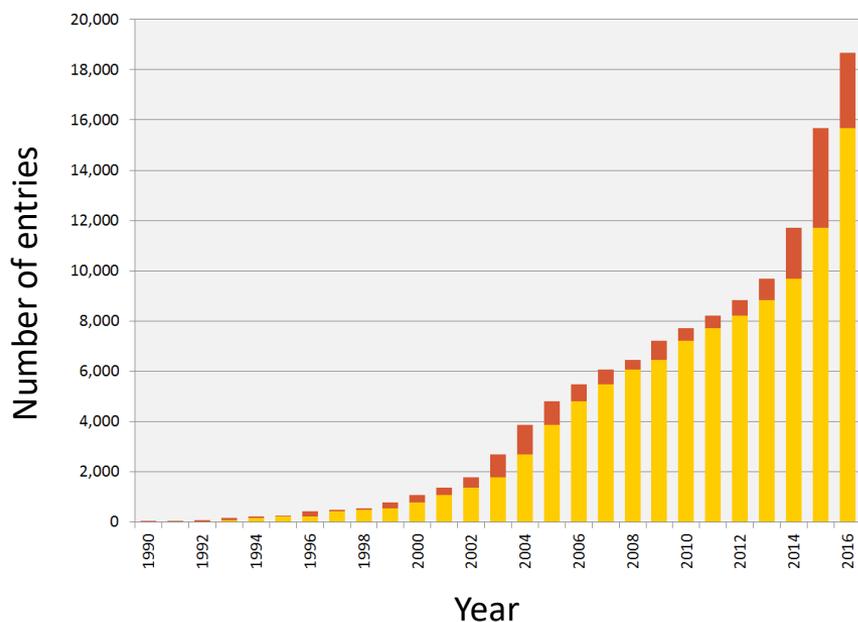
- Not all structures determined get published alongside articles
- Structures can be made available as *CSD Communications*
 - free to create, free to view and download
 - citable with DataCite DOI
 - discoverable through third-party resources
- Reviewed by expert scientific editorial team
 - check for duplicate datasets but not novelty
 - report quality indicators but don't make judgements
 - check there is a plausible chemical interpretation of the data





CSD Communications – outcome so far

- ❑ > 3,000 CSD Communications in 2016
- ❑ Number 1 place to publish in 2016



Thank you very much for your support giving me the chance to know the unpublished data as CSD Communications...With all my best wishes to the team



It is a great pleasure for me to have an opportunity to publish our structures through the CSD



Accessing data

- Anyone can view or retrieve structures in the CSD



New Access Structures

Entry search

Welcome to Access Structures the CCDC's free service to view and retrieve structures in the [Cambridge Structural Database \(CSD\)](#).
Please use one or more of the boxes to find entries in the CSD. If you enter details in more than one field the search will try to find records containing *all* the terms entered. [More information and search help](#)

This is a new pre-release version of Access Structures with additional search functionality. If you have any feedback on this version please email structures@ccdc.cam.ac.uk

CCDC identifier(s) ?

Compound name ?

DOI ?

Authors ?

Journal ?

Publication details

? ? ?



New Access Structures

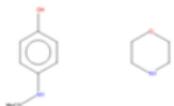
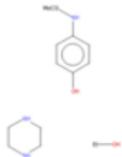
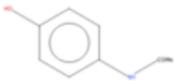
Your query was: Compound name: paracetamol and the search returned more than 30 records.

New Search

Select all

Download Selected

View Selected

<input checked="" type="checkbox"/>	AHEPUY		CCDC identifier(s): 200783 Space Group: P-1 Cell: a 8.710(4)Å b 9.920(5)Å c 12.385(5)Å, α 102.35(3)° β 108.33(2)° γ 96.68(3)° Compound Name: N-(4-Hydroxyphenyl)acetamide morpholine Synonyms: Paracetamol morpholine, Acetaminophen morpholine	
<input checked="" type="checkbox"/>	AMUBAM		CCDC identifier(s): 803736 Space Group: C2/c Cell: a 24.2864(10)Å b 11.3217(5)Å c 16.9668(7)Å, α 90° β 107.988(2)° γ 90° Compound Name: bis(N-(4-Hydroxyphenyl)acetamide) 2-hydroxypropane-1,2,3-tricarboxylic acid Synonyms: bis(Paracetamol) citric acid, bis(Acetaminophen) citric acid	
<input checked="" type="checkbox"/>	COKCEL		CCDC identifier(s): 683518 Space Group: P-1 Cell: a 7.544(5)Å b 8.604(7)Å c 10.394(3)Å, α 93.18(5)° β 97.73(4)° γ 114.70(5)° Compound Name: Paracetamol hemikis(piperazine) ethanol solvate Synonyms: Acetaminophen hemikis(piperazine) ethanol solvate	
<input checked="" type="checkbox"/>	COTZAN		CCDC identifier(s): 735836 Space Group: P21/c Cell: a 14.669(2)Å b 7.8804(11)Å c 10.7272(12)Å, α 90° β 99.439(8)° γ 90° Compound Name: acetaminophen Synonyms: Paracetamol	



CSD Entry: AHEPUY



Your query was: Compound name: paracetamol and the search returned more than 30 records.

[Back to Search List](#)

[New Search](#)

Results

[Previous](#)

[Next](#)

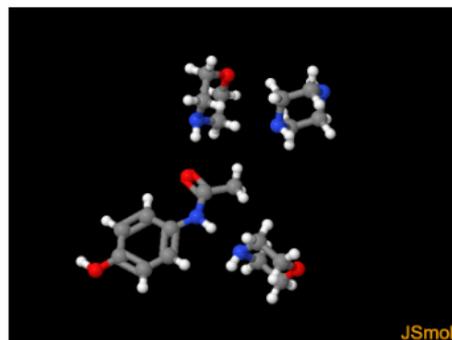
<input checked="" type="checkbox"/>	Refcode	CCDC Number
<input checked="" type="checkbox"/>	AHEPUY	200783
<input checked="" type="checkbox"/>	AMUBAM	803736
<input checked="" type="checkbox"/>	COKCEL	683518
<input checked="" type="checkbox"/>	COTZAN	735836
<input checked="" type="checkbox"/>	COTZAN01	735839
<input checked="" type="checkbox"/>	COTZAN02	735844
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<input checked="" type="checkbox"/>	COTZAN04	735850
<input checked="" type="checkbox"/>	COTZAN05	735833
<input checked="" type="checkbox"/>	CUQKAC	1412589

[Download](#)

AHEPUY : N-(4-Hydroxyphenyl)acetamide morpholine

Space Group: P-1, Cell: a 8.710(4)Å b 9.920(5)Å c 12.385(5)Å, α 102.35(3)° β 108.33(2)° γ 96.68(3)°

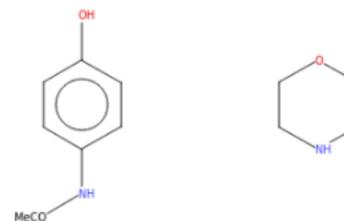
3D viewer



[H](#) [Disorder](#) [Reset](#) [Menu](#) [Open](#)

Style: [Ball and Stick](#) Labels: [No Labels](#) Packing: [None](#) Measure: [None](#)

Chemical diagram



[View group symbols key](#)

Additional CCDC details

CCDC Number	200783
CCDC Citation	I.D.H.Oswald, W.D.S.Motherwell, S.Parsons, C.R.Pulham CCDC 200783: Experimental Crystal Structure Determination, 2002, DOI: 10.5517/cc6qxp
Synonyms	Paracetamol morpholine, Acetaminophen morpholine
Deposited on	16/12/2002

Associated publications

 I.D.H.Oswald, W.D.S.Motherwell, S.Parsons, C.R.Pulham, *Acta Crystallographica Section E: Structure Reports Online*, 2002, 58, 1290, DOI: [10.1107/S1600536802018111](https://doi.org/10.1107/S1600536802018111)

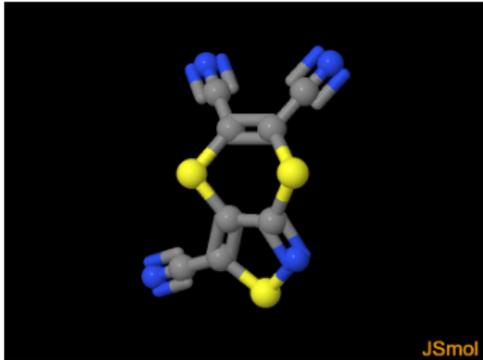


What other data can be accessed?

- Non-CSD structures
 - >10,000 calculated structures

Non-CSD Structure - Calculated Structure [?](#)
Space Group: P-1, Cell: a 6.2931Å b 10.0849Å c 7.8692Å, α 101.686° β 93.5685° γ 82.6778°

3D viewer

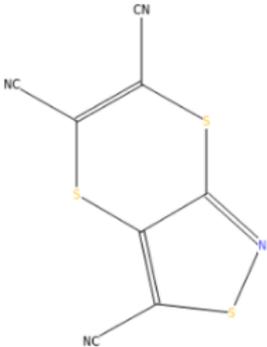


JSmol

H Disorder Menu Open ▾

Style Labels Packing Measure
Ball and Stick ▾ No Labels ▾ None ▾ None ▾

Chemical diagram



[View group symbols key](#)

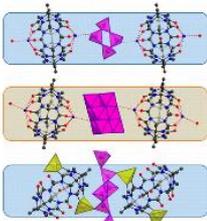
Additional CCDC details

CCDC Number	1452500
Deposited on	10/02/2016



Linking to data from publications

Sandwich-type Inorganic–Organic Hybrid Solids of Iso-polyvanadate Clusters and Decamethylcurcubit[5]uril
Li-Wei Han, Jing-Xiang Lin, Qi Yin, Bahar Karadeniz, Hong-Fang Li, Jian Lü, and Rong Cao
Publication Date (Web): January 15, 2016 (Article)
DOI: 10.1021/acs.cgd.5b01176



CRYSTAL GROWTH & DESIGN

Accession Codes

CCDC: 1032491
CCDC: 1032492
CCDC: 1032493

CSD Entry: NAJYIJ

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Results

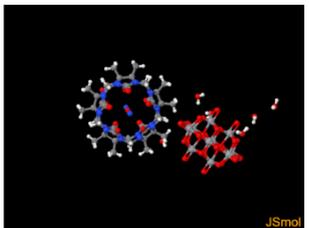
Previous Next

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<input checked="" type="checkbox"/>	NAJYIJ	1032493
<input checked="" type="checkbox"/>	NAJYOP	1032491
<input checked="" type="checkbox"/>	NAJYUV	1032492

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NAJYIJ : tetrakis(ammonium) bis(decamethylcurcubit[5]uril) bis(μ -hydroxy)-octa(oxo)-octadeca(μ -oxido)-deca-vanadium octadecahydrate
Space Group: P-1, Cell: a 14.9979(6)Å b 16.5740(11)Å c 16.6113(8)Å, α 63.456(6)° β 71.772(4)° γ 66.779(5)°

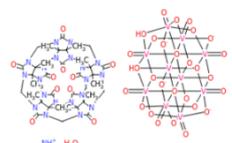
3D viewer



H Disorder ϕ Menu Open -

Style Labels Packing Measure
(Ball and Stick) (No Labels) (None) (None)

Chemical diagram



[View group symbols key](#)

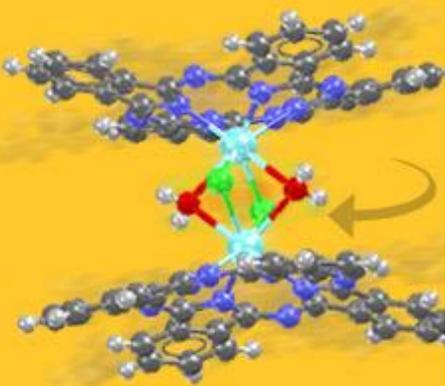
Additional CCDC details

CCDC Number	1032493
CCDC Citation	Li-Wei Han, Jing-Xiang Lin, Qi Yin, Bahar Karadeniz, Hong-Fang Li, Jian Lü, Rong Cao CCDC 1032493: Experimental Crystal Structure Determination, 2014, DOI: 10.5517/cc13nd7d
Deposited on	05/11/2014

Associated publications

Li-Wei Han, Jing-Xiang Lin, Qi Yin, Bahar Karadeniz, Hong-Fang Li, Jian Lü, Rong Cao, *Crystal Growth and Design*, 2016, 16, 1213, DOI: 10.1021/acs.cgd.5b01176

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THE CAMBRIDGE CRYSTALLOGRAPHIC DATA CENTRE



From Data to Knowledge to Applications

Data

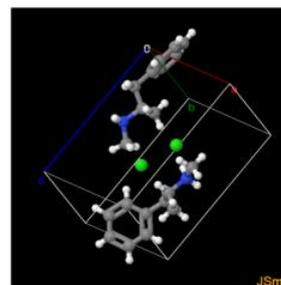
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  _atom_site_refinement_flags
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  _atom_site_symmetry_multiplicity
  _atom_site_disorder_assembly
  _atom_site_disorder_group
C1 C11 0.23185(8) 0.78305(9) 0.55574(6) 0.02213(16) Uani d . 1 1 . . .
N N11 0.8031(3) 0.6811(3) 0.5363(2) 0.0172(4) Uani d U 1 1 . . .
C C1 0.6896(4) 0.7867(6) 0.4357(2) 0.0224(5) Uani d U 1 1 . . .
C C2 0.7510(5) 0.8922(5) 0.7083(3) 0.0256(6) Uani d U 1 1 . . .
C C3 0.7409(4) 0.6944(4) 0.6644(3) 0.0187(5) Uani d U 1 1 . . .
C C4 0.8700(4) 0.5637(4) 0.7481(3) 0.0236(6) Uani d U 1 1 . . .
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Database

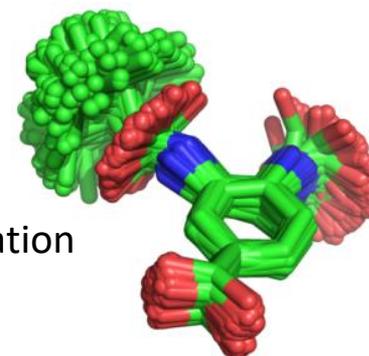
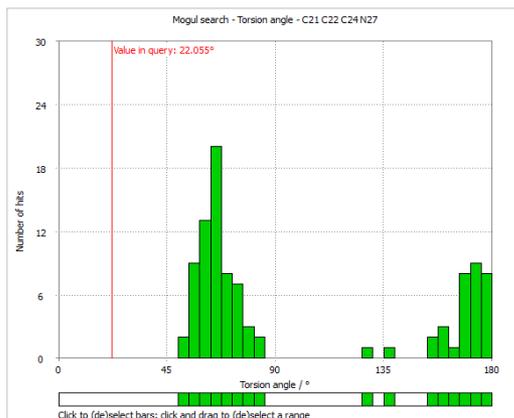
MIYCUT : (+)-Methylamphetamine hydrochloride
Spacegroup: P21, Cell: a 7.1022(11)Å b 7.2949(11)Å c 10.8121(17)Å α 90°
 β 97.293(4)° γ 90°

3D viewer



H Disorder Menu Open -

Knowledge



Application

Chemistry plus crystallography enables discovery and application of new knowledge



Thank you!