EuroSciCon

DAY 1

Scientific Tracks & Abstracts

3rd Edition of International Conference on

Advanced Spectroscopy, Crystallography and Applications in Modern Chemistry

June 04-05, 2018 | London, UK

DAY 1

June 04, 2018

Sessions

Chemical Crystallography | Advanced Crystallography | Crystal Growth| Nuclear Magnetic Resonance Crystallography | Advances in Neutron Diffraction | Biological Structure Determination | Application of Modern Chemistry

Session Chair
Henrich H. Paradies
Jacobs-University, Germany

Session Co-Chair
Vijeesh Padmanabhan
The Cochin College, India

Session Introduction

Title: **Stereochemistry and anti-inflammatory inhibition: Asymmetry complexes of 4-halogenated mofebutazones derivatives**

Henrich H. Paradies, Jacobs-University, Germany

Title: **Synthesis and characterization of triglycinesulphate crystals doped with potassium succinate**

Vijeesh Padmanabhan, The Cochin College, India

Title: **Novel magneto-optic behavior from a polysquaraine: structure / property relationship**

Daniel E. Lynch, Exilica Limited, UK

Title: **High-pressure crystallographic studies in diamond anvil cells using X-rays and neutrons**

Andrzej Grzechnik, RWTH Aachen University, Germany

Title: **NMR Crystallography as a tool for characterization of active sites of solid catalysts**

Olga B. Lapina, Novosibirsk State University, Russia

Title: **Crystallography of oxidized metal(II)- di(phenolate) complexes; Geometric and electronic structures relationship**

Yuichi Shimazaki, Ibaraki University, Japan

Title: **Femtoscope: Atomic Resonance in ATP imposes the necessary and sufficient conditions for cancer efficient radiotherapy**

Nicolas Recalde, South Carolina University, USA

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Henrich H. Paradies et al., Struct Chem Crystallogr Commun 2018, Volume 4
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STEREOCHEMISTRY AND ANTI-INFLAMMATORY INHIBITION: ASYMMETRY, AND COMPLEXES OF 4-HALOGENATED MOFEBUTAZONES DERIVATIVES

Henrich H. Paradies[1] and **Hendrick Reichelt**[2]
[1]Jacobs-University, Germany
[2]Salford University, United Kingdom

The role of halogens in racemic 4-hal-4-butyl (n-octyl)-1-phenyl derivatives (hal: F, Cl, Br), of the cyclic pyrazoline-(1,3)-diones in the solid state and in solution was determined [1]. Noncovalent interactions are observed for the F, Cl and Br derivatives between the halogen atom and the hydrogen atom of the nitrogen of the pyrazolidine ring, water hydrogens that interact either with the halogen atoms or with the carbonyl oxygen atoms very different from the none-halogenated pyrazoline-diones [2-5]. The 3d and 2d structures are stabilized by - and - interactions, intermolecular distances, and apolar forces between adjacently stacked phenyl rings. However, the R-or S-enantiomers or their water-stable complexes with Zn-meglumine did not racemizes in aqueous dispersions [1,3]. Small-angle-, wide-angle x-ray scattering experiments, and molecular simulation reveal similar solution structure factors, S(Q), in the solid state and in solution [6,7]. The planes and their periodicities of the crystalline phases are preserved in the aqueous solution phase. There is also hydrogen bonding formed in the racemic and the R-enantiomeric n-octyl-1-phenyl-1-Cl-pyrazoline-(1,3)-dione between the hydrogens of the water molecules and the halogens of the pyrazolidine ring: Cl forms a hydrogen bond to the water hydroxy group of a neighbouring molecule, which is hydrogen bonded to the chlorine of another molecule forming a 1-dimensional hydrogen-chloride bond network differently from hydrated cationic lipids or their polymorphs [8,9]. The n-octyl pyrazolidine approximant forms micelles in aqueous dispersions that self-assemble into quasicrystalline structures. The small-angle X-ray scattering experiments and the selected area electron diffraction pattern of thin films suggest that the micelle FCC phase transforms into a colloidal quasicrystalline phase with 12-fold symmetry that proceed through rearrangements of the micelles in the (111) layers of the FCC phase. The differences of the halogenated cyclic and non-cyclic pyrazoline diones are related to biochemical changes in anti-inflammatory activities. The n-octyl compound reveal antimicrobial and antiviral (influenza) activities but no anti-inflammatory or analgesic activities.

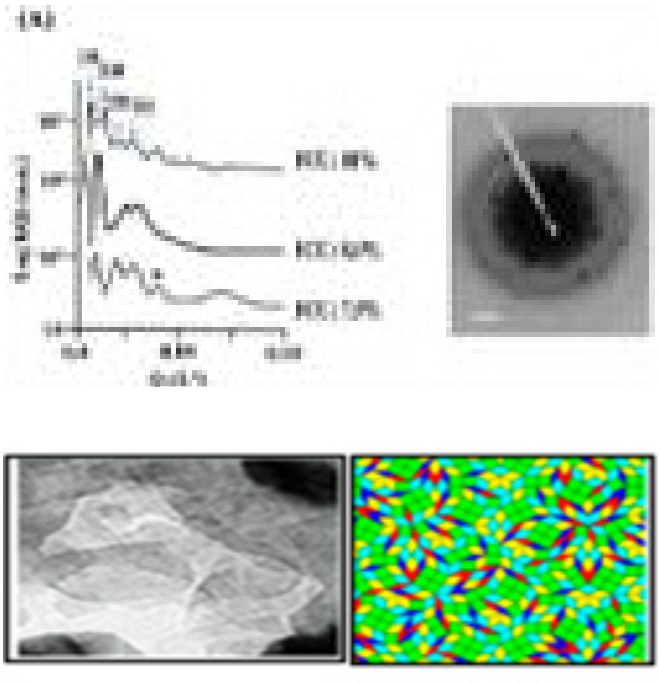

Fig.1. (Left) SAXS curves for isotropic (R,S)-4-n-octyl-4-Cl-1-phenyl-3, 5-pyrazolidine-dion samples for different concentrations (20°C). For the 19% (w/w), 8.0% (w/w) and 7.5% (w/w) solutions the Q-positions of the observed structure peaks of the scattering curves can be simulated with and a = 50.0 Å. The broad reflection at Q = 0.035 Å-1 correspond to the 11110 reflections of a face-centerd cubic lattice (Fm3m) of the crystalline phase (20°C). The scale bar 30 nm. (Middle) HRTEM image of quasicrystals obtained from a 7.5% (w/w) (R,S)-n-octyl-Cl-phenyl-3,5-pyrazolidine-dion solution. (Right) Tiling pattern generated from the tessellation graphic (middle) applying triangles and squares for two Archimedean (3342) materials: three domains in tortoise, red and blue assigned to the p4g and two domains, green and yellow for the p6m approximants

Recent Publications

1. Reichelt H., Paradies H.H. (2018) Structures and anti- inflammatory properties of 4-halogenated-mofeburazones. J. Mol. Structure, 1154: 204-218.
2. Paradies H.H., Ziedrich H.K., Flämig, H. H. (1990) Structural studies on mofebutazone derivatives and their in-vitro activities. J. Med. Chem. 25: 143-156.
3. Paradies H.H, (1987) Structure of phenylbutazone and mofebutazone in the crystalline state and in solution. J. Pharm.Sci.76:820-929.
4. Paradies H.H., Ziedrich H.K., Flämig H. H. Gan T. G. (1987) Keto-enol tautomer of 1-phenyl-4n-butyl-pyrazolidin- (1,5) - dione. Acta Technol. 33:180-188.
5. Paradies H. H., Schulte K.E. (1988) The Role of 2-(S)-n-Butyl- (1-Phenyl-Hydrazino-Carbonly)-Hexanoic Acid in the Anti- Inflammatory Process, Ann. New York Acad. Sci. 529: 221- 227.
6. Reichelt H., Faunce C. A., Paradies H. H. (2015) Structures of the 2-nitrophenol alkali complexes in solution and the solid state, J. Chem. Phys. 143: 044307-044324.
7. Paradies H. H., Reichelt, H. (2016) Influence of the anions on the N-cationic benzethonium salts in the solid state and solution: Chloride, bromide hydroxide and citrate hydrates, AIPAdvances6:065322-065346.
8. Paradies H. H., Habben F. (1990) The crystal and molecular structure of hexadecylpyridinium chloride, Acta Cryst.: C 49, 744-748.
9. Alonso B., Massiot D., Florian P., Paradies H. H., Gaveau P., Mineva T. (2009) 14N and 81Br quadrupolar nuclei as sensitive NMR probes of n-alkyl trimethylammonium bromide crystal structures. An experimental and theoretical study, J. Phys. Chem. B.113: 11906-11920.

Biography

Prof. Henrich H. Paradies, FRSC & CC, MD, Ph.D., Ph.D., D.Sc. (h.c.) studied bioinspired, smart and multi-scale materials with defined wettabilities of cationic lipids as components in antiviral, antibacterial, and anti-inflammatory ingredients, the inhibition of viral activities on the level of monomer or aggregated sizes (cyclic peptides), adherence for brushy surfaces by clinging to flaws and function of the organization on their specific head groups e.g. ammonium vs. phosphonium groups, Zn-cationic lipid-alendronate complexes or cyclic peptides with antimicrobial activities. The uptake of these materials is dependent on free diffusion, micelle endocytosis, distribution through the cytoplasms and disassembles into monomer to unfold full biological activities. A unique role plays the lipid A-phosphates and their approximants as antagonist for chronic inflammation, food poisoning, allergens and resistance against antibiotics. The mechanics and physics of these supramolecular assemblies were analyzed in terms of bond-orientational order, mean field phase diagram and disproportionate crystals or quasicrystals. (orcid.org/0001-0003-9409-3471).

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SYNTHESIS AND CHARACTERIZATION OF TRIGLYCINE SULPHATE CRYSTALS DOPED WITH POTASSIUM SUCCINATE

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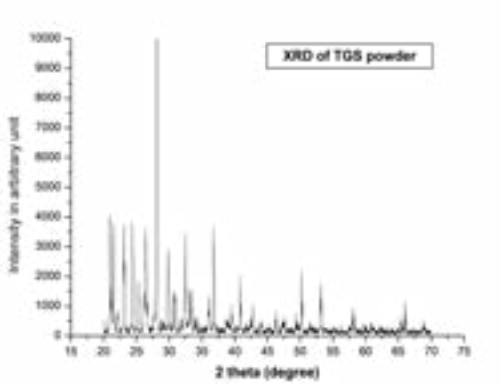
The Cochin College, India

Tri glycine sulphate $(NH_2CH_2COOH)_3.(H_2SO_4)$ (TGS) is a ferroelectric and pyroelectric crystal which is mainly used for infrared detector applications. The b axis of TGS is the ferroelectric axis (axis of spontaneous polarization) and along this axis it exhibits maximum pyroelectric coefficient of ~ 3 × 10-2 μC cm-2 K-1 at room temperature [1]. Due to this reason the (010) face assumes importance in the morphology of TGS crystal. The work described in the present report is an attempt to study the evolution of the morphology of TGS crystal in general and (010) face area relative to other faces in particular and also to characterize the grown crystal for its phase and optical homogeneity using X-ray diffraction and optical interferometric techniques. Also to study the effect of dopping of TGS with potassium succinate. TGS is known to undergo a second order (order-disorder type) continuous phase transition at the Curie temperature (Tc) of 49°C. Below this temperature the crystal exhibits ferroelectric phase whereas above it the crystal gets transformed to the paraelectric phase [2]. It belongs to monoclinic system below and above the Curie temperature. It has space group P21 in the ferroelectric phase and cento-symmetric space group P21/m in the paraelectric phase [3]. The lattice parameters of TGS are a=9.41Å, b=12.64 Å, c=5.73 Å and β=110°23' [4]. Due to its self poling nature it does not require any specific poling when it is cooled from the high temperature phase to the low temperature one. Taking advantage of this characteristic of TGS, and the fact that across the Curie temperature the dipole moments of the domains will behave differently which will influence the growth rate of the (010) polar face, we have attempted to grow TGS crystal . The morphology of TGS crystal in general and (010) face in particular is studied. Also we attempted to study doping induced morphological changes of TGS using Potassium Succinate as dopant.



Recent Publications

1. Vijeesh P, Dr. Annieta Philip K, Dr. Supriya M.H (2016) Growth and growth rate analysis of potassium succinate crystal. N.S.C.G.A, Bhabha Atomic Research Center, Mumbai, India
2. Vijeesh P, Paulbert Thomas, Dr. Annieta Philip and Dr. Supriya M.H (2016), Growth rate analysis and material characterization of potassium succinate crystal. Smart Materials for Futuristic Electronics and Communication Technology, The Cochin College, Kochi-2.

Biography

Vijeesh P has his expertise in synthesis and characterization of Non linear optical materials and their characterization. He designed a crystallizer for slow cooling solution growth for the synthesis of the materials. And also designed a temperature controller for slow cooling of the solution. He is an Assistant Professor in Physics, Department of Physics, The Cochin College, India. He presently doing his research in Department of Electronics , The Cochin University of Science and Technology. He got slected for research fellowships by Indian Academy of Science and did research work in Raja Ramanna Center for Advanced Technology, India.

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NOVEL MAGNETO-OPTIC BEHAVIOR FROM A POLYSQUARAINE: STRUCTURE / PROPERTY RELATIONSHIP

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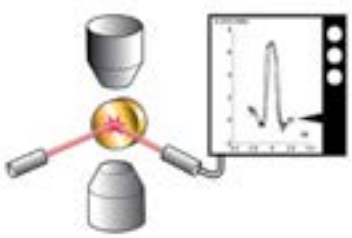
Poly((2,5-bis(1-methylpyrrol-2-yl)thiophene)squaraine) can be synthesized as a dark green insoluble powder which when subjected to shear force and pressed as a disk exhibits a gold-green near optical quality surface with semi-metallic behaviour. Reflectivity measurements at a wavelength of 819 nm reveal a high (72°) pseudo-Brewster angle and non-zero p-reflectivity whilst electrical measurements using a four-point probe return a conductivity of 1 x 10-5 S.cm-1. Unexpectedly the disks also exhibit magneto-optic (MO) activity which it appears must arise from a weak magnetic component intrinsic to the samples. In both the longitudinal and transverse Kerr configurations large fractional changes in reflectivity (ΔI/I ≈ 2.5x 10-2) are observed across a wide range of angles of incidence for wavelengths between 400 nm and 1064 nm on application and reversal of a magnetic field. Anomalously for these configurations all the MO effects observed are quadratic in the applied field and no first-order effects linear in applied field are observed for any state of incident polarisation. Examined using conventional magnetometry disk samples return saturation magnetization values of 4.13 x 10-3 emu.g-1 on a vibrating sample magnetometer and smaller samples similarly processed and prepared for examination by Squid magnetometer confirmatory values of 4.9 x10-3 emu.g-1. Magnetization curves from both instruments have a similar form saturating at about 1.14 kOe and are also in close correspondence with curves derived by plotting the magneto-optic signal as a function of field. Similarly both the magnetic and magneto-optic behaviour of all samples is isotropic in plane.All experimental observations on this polymer appear to be commensurate with the development of some form of magnetic state throughout very limited regions of the material. A model able to reconcile the magnetic and MO observations is presented as well as a discussion of the importance of the material structure in relation to the observed phenomenon.



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1. **Lynch DE, Hamilton DG (2018) Microreview: Pyrrol-3-yl squaraines (including indol-3-yl squaraines). Journal of Heterocyclic Chemistry DOI: 10.1002/jhet.3173.**
2. **Lynch DE, Hamilton DG (2017) Croconaine Dyes – the Lesser Known Siblings of Squaraines. European Journal of Organic Chemistry 3897-3911.**
3. **Lynch DE, Hamilton DG (2017) The History of Azulenyl Squaraines. Australian Journal of Chemistry 70:857-871.**
4. **Lynch DE (2015) Pyrrolyl Squaraines – Fifty Golden Years. Metals 5: 1349-1370.**
5. **Lynch DE, Newman DM, Wears ML, Matelon RJ (2013) Novel magneto-optic behavior from a polysquaraine. Synthetic Metals 171:15-22.**

Biography

Daniel Lynch is a materials chemist and crystallographer with recent experience in plastics additives; BAppSc degree (1990) and PhD (1994), from QUT in Brisbane (Australia). A postdoctoral fellowship at Cranfield University (UK) preceded a six-year university research fellowship at Coventry University (UK), becoming a Senior Lecturer in 2001 and a Reader of Applied Chemistry in 2007 at the same institution. He is the author of 250 research publications, the principal inventor of Exilica's patented technology and became the full-time Technical Director of Exilica Limited in 2007, a post that he had held on a part-time basis since Exilica's incorporation in May 2005. (orcid.org/0000-0001-6210-5316).

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HIGH-PRESSURE CRYSTALLOGRAPHIC STUDIES IN DIAMOND ANVIL CELLS USING X-RAYS AND NEUTRONS

Andrzej Grzechnik
RWTH Aachen University, Germany

A diamond anvil cell (DAC) is the most versatile tool to study structures and physical properties of (non-)crystalline materials at high pressures. The range of experimental techniques in a DAC is very broad: synchrotron and X-ray diffraction, inelastic X-ray scattering, optical and vibrational spectroscopies, etc. However, the main disadvantage of the DAC is a limited sample volume that is available in the sample chamber. Owing to the development of modern two-dimensional detectors and radiation sources, high-pressure single-crystal X-ray diffraction in the DAC using laboratory and synchrotron facilities can now be performed on complex crystal structures that are twinned or modulated. On the other hand, there are hardly any single-crystal neutron diffraction studies in the DAC that would present complete structural refinements. Up to now, even at the most advanced neutron facilities it is difficult to routinely study crystals with volumes below 1 mm3 due to the low flux of the neutron beams. The requirement for large samples hinders a joint use of X-ray and neutron single-crystals diffraction upon compression. The combination of both techniques is highly advantageous for detailed studies on crystalline compounds, as neutron diffraction plays a crucial role in those cases where X-ray diffraction fails to provide information on, for instance, magnetic order or compounds containing light elements. Recently, we have started to explore the feasibility of neutron measurements in the DAC on the single-crystal diffractometer HEIDI at the Heinz Maier-Leibnitz Zentrum (MLZ) in Garching (Germany) that offers the benefit of various short wavelengths with high fluxes. We have now developed optimized DACs for measurements on crystals smaller than 0.1 mm3 at room and low temperatures in the transmission and radial (panoramic) neutron scattering geometries. Some of these DACs could well be used for combined X-ray and neutron investigations.

Recent Publications

1. Friese, K., Grzechnik, A., Posse, J.M., Petricek, V. (2013) - Refinement of high-pressure single-crystal diffraction data using Jana2006 – High Pressure Research, 33, 196.
2. Friese, K., Grzechnik, A. (2014) – Twinning and pseudosymmetry under high pressure – Z. Kristallogr.229, 158.
3. Grzechnik, A., Ueda, Y., Yamauchi, T., Hanfland, M., Hering, P., Potapkin, V., Friese, K. (2015) - Structural stability of the Wadsley-type bronzes -Ag0.33V2O5 and -Li0.33V2O5 on compression: a break-down of the two-leg ladder system in the non-superconducting high-pressure phase of -Li0.33V2O5 – Phys. Rev. B 91, 174113.
4. Grzechnik, A., Yeon, J., zur Loye, H.-C., Friese, K. (2016) - High-pressure behaviour of Cs2V3O8 – J. Solid State Chem. 238, 252-258.
5. Friese, K., Khaidukov, N., Grzechnik, A. (2016) - Twinned CsLn2F7 compounds (Ln = Nd, Gd, Tb, Er, Yb): the role of a highly symmetrical cation lattice with an arrangement analogous to the Laves phase MgZn2 – Z. Kristallogr., 231, 631-639.

Biography

Andrzej Grzechnik is a staff scientist at the Institute of Crystallography, RWTH Aachen University (Germany). He has completed his PhD in chemistry from the Arizona State University in 1996. Since then, he has been working on various topics in the fields of crystallography, materials science, solid state chemistry, condensed matter physics, and applied mineralogy. He has served as a board member of various scientific meetings and review panels. Currently, he is a Chair of the Special Interest Group on Crystallography of Functional Materials (SIG#12) of the European Crystallographic Association.

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NMR CRYSTALLOGRAPHY AS A TOOL FOR CHARACTERIZATION OF ACTIVE SITES OF SOLID CATALYSTS

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[2]Novosibirsk State University, Russia

NMR crystallography combines state-of-the-art high-resolution solid-state NMR experiments with state-of-the-art quantum chemistry calculations thus allowing determining structural and dynamic characteristics in a variety of systems. In this work, we are going to demonstrate different steps of NMR crystallography approaches with an example of supported oxide catalysts. The recent advances in NMR of oxide-based systems are primarily associated with the achievements in NMR spectroscopy of quadrupolar nuclei since the majority of NMR-observable isotopes of elements composing oxide systems possess quadrupole moments. Ultra-high magnetic fields (up to 23.5 T), ultra-high sample spinning (~ 100 kHz), as well as modern electronic components and devices together with a number of software programs allowing researchers to extract parameters of chemical shift and nuclear quadrupole interaction tensors, as well as their mutual orientation. The first step of the study was to test NMR crystallography approach on individual compounds. After, experimental NMR parameters of real catalysts were determined. Based on values obtained, several sets of models were proposed. For suggested models, NMR parameters were calculated by DFT. When a good matching between experimental and calculated NMR parameters was achieved, it was concluded that the 3D structure of surface sites is identified. It is very important that NMR crystallography in application to catalysts could serve not only for characterization of structure of surface sites, but also for characterization of their catalytic activity, for this we have to check catalytic activity of different sites by probe molecules (both experimentally and theoretically). The next step was connected with adsorption of test molecules (H2O, CO2, CH3OH, etc.) on real catalysts (experimental part) and on model surface sites (theoretical part). At this stage, it is reasonable to use additional experimental techniques (for instance, FTIR). In case of good agreement between experimantal and theoretical parameters, it is possible to determine 3D structures of active sites.

Acknowledgements: Authors thank funding provided via RFBR projects № 17-03-00531.

Recent Publications

1. O.B. Lapina, V.V. Terskikh (2012) Quadrupolar Metal NMR of Oxide Materials Including Catalysts' Chapter 27, in NMR of Quadrupolar Nuclei in Solid Materials. Wasylishen, R.E., Ashbrook, S.E. and Wimperis, S. (eds). John Wiley & Sons Ltd, Chichester, UK, pp 467-494.
2. O.B. Lapina, (2017), Modern ssNMR for heterogeneous catalysis, Catal. Today, 285, 179.
3. E. Papulovskiy, D.F. Khabibulin, V.V. Terskikh, E.A. Paukshtis, V. M. Bondareva, A.A. Shubin, A.S. Andreev, and O.Lapina, (2015) Effect of Impregnation on the Structure of Niobium Oxide/Alumina Catalysts Studied by Multinuclear Solid-State NMR, FTIR, and Quantum Chemical Calculations, J. Phys. Chem.C, 119, 10400−10411.
4. A.S. Andreev , N.V. Bulina, M.V. Chaikina, I.Yu. Prosanov, V.V. Terskikh, O.B. Lapina, (2017) Solid-state NMR and computational insights into the crystal structure of silicocarnotite-based bioceramic materials synthesized mechanochemically, Solid State Nuclear Magnetic Resonance 84, 151–157.
5. A.S. Andreev, M.A. Kazakova, A.V. Ishchenko, A.G. Selyutin, O.B. Lapina, V.L. Kuznetsov, J.-B.d'Espinose de Lacaillerie, (2017) Magnetic and dielectric properties of carbon nanotubes with embedded cobalt nanoparticles, Carbon, 114, 39-49
6. I.V. Yakovlev, A.M. Volodin, E.S. Papulovskiy, A.S. Andreev, O.B. Lapina, (2017) Structure of Carbon-Coated C12A7 Electride via Solid-State NMR and DFT Calculations, J.Phys.Chem.C 121, 22268.
7. A.S. Andreev, D.V. Krasnikov, V.I. Zaikovskii, S.V. Cherepanova, M.A. Kazakova, O.B. Lapina, V.L.

Kuznetsov, J.–B. d'Espinose de Lacaillerie, (2018) Internal field 59Co NMR study of cobalt-iron nanoparticles during the activation of CoFe2/CaO catalyst for carbon nanotube synthesis, Journal of Catalysis 358 62–70.

Biography

Olga B.Lapina, Graduated Novosibirsk University (1976), received PhD in 1984, Prof. Dr.S. from1995. Leading Researcher, Head of SSNMR group of Boreskov Institute of Catalysis, Novosibirsk, Russia. She has extensive expertise in modern multinuclear solid-state NMR spectroscopy and applications of magnetic resonance techniques in materials sciences and catalysis. She has been a chair of several international conferences (including EUROMAR-2008) and workshops. Last years she works on application of NMR crystallography for catalyst characterization. (ORCID 0000-0002-9911-7617).

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CRYSTALLOGRAPHY OF OXIDIZED METAL(II)- DI(PHENOLATE) COMPLEXES; GEOMETRIC AND ELECTRONIC STRUCTURES RELATIONSHIP

Yuichi Shimazaki
Ibaraki University, Japan

Oxidation chemistry of redox active transition metal complexes with pro-radical ligands and their detailed electronic structures have been actively pursued in recent years. An "experimental" valence state of metal complexes is sometime different from the "formal" oxidation state, especially in the species having redox active ligands. This difference can be seen in biological system, such as iron(IV)-porphyrin -cation radical in some heme proteins and copper(II)-phenoxyl radical in galactose oxidase (GO). Many efforts for determination of the experimental oxidation number have been close to the goal of the "truth oxidation state" in various oxidized metal complexes with redox-active ligands. Depending on the relative energies of the redox-active orbitals, metal complexes with non-innocent ligands exist in two limiting descriptions, either a metal-ligand radical (Mn+(L•)) or a high valent metal (M(n+1)+(L)) complex. The reaction mechanisms of artificial and biological catalysts depend on the electronic structures of the high valent intermediates. However, structural characterizations of these species by X-ray diffraction methods have been rare due to their stability. Recently, some artificial metal−phenoxyl radical complexes as models of GO have been synthesized and successfully characterized by X-ray crystal structure. The one-electron oxidized metal-phenolate complexes showed various electronic structures depending on small perturbations, such as substitution of the phenolate ring and the chelate effect of the phenolate ligands and so on. In this presentation, I will focus on X-ray crystal structures of the one- and two-electron oxidized metal(II)−phenolate complexes (Ni(II), Pd(II), Pt(II) and Cu(II)) with Schiff base ligands of 2N2O donor sets. Especially electronic and crystal structure relationship such as differences of metal-phenoxyl radical and high-valent metal phenolate complexes, and the effect of different oxidation locus of the radical electron on the ligands in oxidized forms will be discussed.

Recent Publications

1. **Oshita H, Shimazaki Y, Yamauchi O, et al. Characterization of the one-electron oxidized Cu(II)-salen complexes with a side chain aromatic ring: The effect of the indole ring on the Cu(II)-phenoxyl radical species. J. Bio. Inorg. Chem., in press.**
2. **Oshita H, Shimazaki Y, et.al. Group 10-Metal-p-Substituted Phenoxyl Radical Complexes with Schiff Base Ligands. ChemSelect., in press.**
3. **Shimazaki Y, Yajima T, Yamauchi O. (2015) Properties of the indole ring in metal complexes. A comparison with the phenol ring. J. Inorg. BioChem, 148: 105-115.**

Biography

Yuichi Shimazaki was born in 1970 in Toyama prefecture, Japan. He received his Doctor's degree in science from Nagoya University in 2000 under the supervision of Professor Osamu Yamauchi. He joined Professor Yoshinori Naruta's group at Kyushu University as Assistant Professor and worked on the redox behavior of various metal porphyrin complexes as models of the active site of metalloenzymes. In 2008 he was promoted to Associate Professor at the College of Science, Ibaraki University. His research interests include the oxidation chemistry of the complexes of various metal ions, model studies of metalloenzymes, bioorganometallic chemistry, and weak interactions in metal-organic molecule systems.

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FEMTOSCOPE: ATOMIC RESONANCE IN ATP IMPOSES THE NECESSARY AND SUFFICIENT CONDITIONS FOR CANCER EFFICIENT RADIOTHERAPY

Nicolas Recalde[1] and **Edward Jimenez**[2]
[1]South Carolina University, USA
[2]Central University, Ecuador

The success of Medical Physics and Oncology in the treatment of prostate and breast cancer, with an efficiency greater than 99%, shows us that the resonance produced by the equality of the wavelength of Rx and the Bohr radius at low energies is a sufficient condition for an efficient cancer radiation treatment, while ionization is the necessary condition. Biochemistry and Biophysics converge to demonstrate that the fundamental goal for cancer cure is to inhibit the synthesis of ATP in the cell nucleus and selectively attack tumor cells. We propose that it is possible to achieve a regeneration of ATP at the mitochondria through a resonance of the phosphorus bonds. A resonance region is created in a natural way at the K-shell between the nucleus and the electrons at S-level. The condition for the photons to enter into the resonance region is given by ra>rn + λ.

The efficiency of radiotherapy is a function of resonance, ionization and the effective cross-section of phosphorus within the ATP, in terms of correcting cellular metabolism in mitochondria. In addition, resonance is one of the causes of ionization and allows us to measure the efficiency of radiotherapy, which was corroborated with Monte Carlo simulation performed with Geant4. The cancers treated with low energy are cured, because resonances are created in the atom of phosphorus which is a component of the DNA. The other DNA atoms such as: H, C, N and O do not have resonances giving this way stability to the DNA. The phosphorus atom has larger X-ray resonances among the DNA components, having an energy threshold of 2146 eV according to NIST and 1992 eV according to Geant4. We then conclude that radiation cancer treatment using X-rays is efficient only when they produce resonances. We have also coined the term femtoscope which measures dimensions and interactions in the range of femtometers.

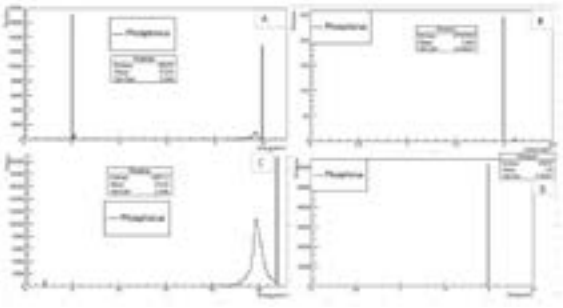

Figure 1. Phosphorus resonance peaks. We can see the resonance peaks obtained using Geant4 Monte Carlo Code for different energy limits of the primary photons. Figure A shows absorption peak at 1992 eV, which was a result of the resonance when using 10 kV primary photons. The peak at 10 keV is due to photons that did not have any interaction at phosphorus target. We also have a Compton effect peak. The graphs B, C, D also indicate resonance peaks at 1992 keV for primary photons at different energies.

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4. **Hubbell, J.H and Seltzer, S.M. X-ray Mass Attenuation Coefficients, Radiation Division, PML, NIST, 2017. Available online: https://www.nist.gov/pml/x-ray-mass-attenuation-coefficients (accessed on 01 May**

2017).

5. **Edward Jiménez, Nicolas Recalde and Esteban Jiménez, Extraction of the Proton and Electron Radii from Characteristic Atomic Lines and Entropy Principles. Entropy 2017**

Biography

Nicolas Recalde, has worked for 15 years in cancer radiotherapy at Georgetown University Medical Center and Inova Health System, USA. He was Chief Medical Physicist at Potomac Radiation Center in Virgina, USA. Currently he is pursuing his doctorate degree in Physics at University of South Carolina, USA. His research is about low energy associated with miniature X-ray sources and their use for cancer treatment. He is a diplomate of the American Board of Radiology and a member of the American Association of Physicists in Medicine.

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DAY 2

Scientific Tracks & Abstracts

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DAY 2

June 05, 2018

Sessions

Crystallography of Novel Materials | Spectroscopy Applications | Crystallography Applications | Crystallography in Biology

Session Chair
Marie-Helene Lemee-Cailleau
Institut Laue Langevin, France

Session Co-Chair
Yuichi Shimazaki
Ibaraki University, Japan

Session Introduction

Title: **Neutron Laue and X-ray diffraction study of a new crystallographic superspace phase in n-nonadecane–urea**
Marie-Hélène Lemée-Cailleau, Institut Laue Langevin, France

Title: **Fluorination of cuspidine-related phases, $Ln_4Al_2O_9$ (Ln=Sm, Eu, Gd, Tb)**
Aroa Morán-Ruiz, University of the Basque Country, Spain

Title: **Fluorescence in quantum systems with violated symmetry**
Nikolai N. Bogolubov (Jr.), Mathematical Institute of the RAS, Russia

Title: **Antibody-enabled small molecule drug discovery**
Alastair Lawson, UCB, Slough, UK

Title: **CrystalCMP – Fast packing comparison of molecular crystals**
Jan Rohlíček, Institute of Physics, ASCR, Czech Republic

Title: **Frag Xtal Screen for direct crystallographic fragment screening**
Christin Reuter, Jena Bioscience GmbH, Germany

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Marie-Helene Lemee-Cailleau, Struct Chem Crystallogr Commun 2018, Volume 4
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NEUTRON LAUE AND X-RAY DIFFRACTION STUDY OF A NEW CRYSTALLOGRAPHIC SUPERSPACE PHASE IN N-NONADECANE–UREA

Marie-Helene Lemee-Cailleau
Institut Laue Langevin, France

Aperiodic composite crystals present long-range order without translational symmetry. These materials may be described as the intersection in three dimensions of a crystal which is periodic in a higher-dimensional space. In such materials, symmetry breaking must be described as structural changes within these crystallographic superspaces. The increase in the number of superspace groups with the increase in the dimension of the superspace allows many more structural solutions. We will present recent results obtained by complementary Laue neutron diffraction and X-ray diffraction techniques on n-nonadecane-urea, a nice illustration of aperiodic materials. Within this original family of alkane-urea composites, we will illustrate how structural phase transitions are characterized by changes of intermodulation and described by increasing the rank of the associated crystallographic superspaces.

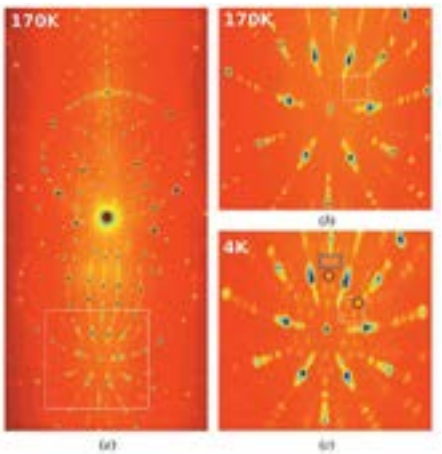

Figure 1:

(a) Laue diffraction image of n-nonadecane–urea at T=170K (phase I)
(b) Expansion of the selected region of the diffraction pattern at 170K
(b) same area at 4K

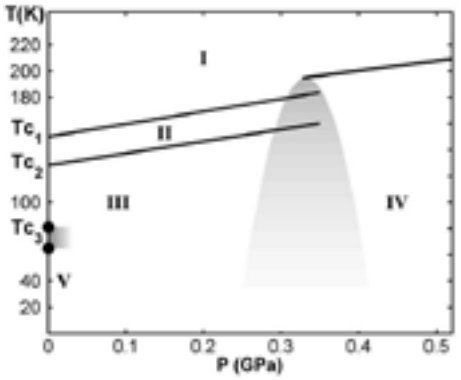

Figure 2:

Phase diagram (T,P) of the fully deuterated n-nonadecane–urea [1,2]. All the phases, I, II, III, IV and V, require a description within a crystallographic superspace. Shaded region indicates the metastable region between the ordered low-pressure and high-pressure phases. The two points associated with TC3 mark the metastability limit between phase III and phase V [1]

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7. Szeleg E., Zuzens B., Hawthorne F.C., Pieczka A., Szuszkiewicz A., Turniak K., Nejbert K., Ilnicki S.S., Friis H., Makovicky E., Weller M.T., Lemée-Cailleau M.H.

8. Bohseite, ideally Ca4Be4Si9O24(OH)4, from the Piława Górna quarry, the Góry Sowie Block, SW Poland; Mineralogical Magazine (2017) 81, 35-46.

Biography

Marie-Hélène Lemée-Cailleau is expert in phase transition of molecular solids under various external controlled parameters, like temperature, pressure or light. Her speciality is single crystal neutron diffraction, using either monochromatic or polychromatic techniques, as well as X-ray diffraction (table-top or synchrotron), and all related structural analysis. She is physicist in the Science division of the Institut Laue Langevin, the European Neutron Source, located in Grenoble, France, and member of the French and European Crystallographic associations. (orcid.org/0000-0003-4733-4334).

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FLUORINATION OF CUSPIDINE-RELATED PHASES, $Ln_4Al_2O_9$ (LN=SM, EU, GD, TB)

Aroa Moran-Ruiz[1], Aritza Wain-Martín, Alodia Orera, María Luisa Sanjuán, Aitor Larrañaga, Peter R. Slater and **Maribel Arriortua**

University of the Basque Country, Spain

The structural properties of the $Ln_4Al_2O_9$ (Ln=rare-earth) type phases have attracted attention because of their ionic conductivity and thermal stability [1-3]. Minerals belonging to the cuspidine group have the following general stoichiometry: $M_4(Si_2O_7)X_2$ (M= divalent cation; X= OH, F, O), with $Ca_4(Si_2O_7)$ (OH,F)2 being the archetype compound. The cuspidine structure can be described as built up of chains of edge-sharing MO_7/ MO_8 polyhedra running parallel to the a-axis (in the P21/c space group) with tetrahedral disilicate groups, Si_2O_7, interconnecting these ribbons through the vertexes [3]. In more recent years the preparation and characterization of inorganic oxide fluorides has attracted significant interest [4]. Given the recent studies on oxide ion/proton conductivity in $La_4(Ga_2\text{-}xTixO_7+x/2)O_2$, illustrating the ability of the cuspidine structure to accommodate extra anions [5], we have investigated the possible incorporation of fluorine into $Ln_4Al_2O_9$ to give $Ln_4Al_2O_9\text{-}xF_2x$ (Ln= Sm, Eu, Gd, Tb) (0≤x≤1). We report here on the results of the fluorination of a range of cuspidine-related phases of composition $Ln_4Al_2O_9$ (Ln=Sm, Eu, Gd, Tb). The introduction of fluorine (2F- replace $1O_2$-) is achieved through a low-temperature (400ºC) reaction with poly(vinylidene fluoride) (PVDF) or poly(tetrafluoroethylene) (PTFE). We investigate the effects of fluorination on the starting structure by X-ray diffraction, Raman spectroscopy and X-ray photoelectron spectroscopy. The thermal stability of these samples before and after fluorination was evaluated in air. The starting materials $Ln_4Al_2O_9$ (Ln=Sm, Eu, Gd, Tb) showed a monoclinic crystal structure with space group of P21/c (Figure 1), as was expected. The XRD patterns show that fluorination induces a shift in peak position to lower angles corresponding to an increase in unit cell sizes as the total anion content increases. The characterization of these new systems will be reported.

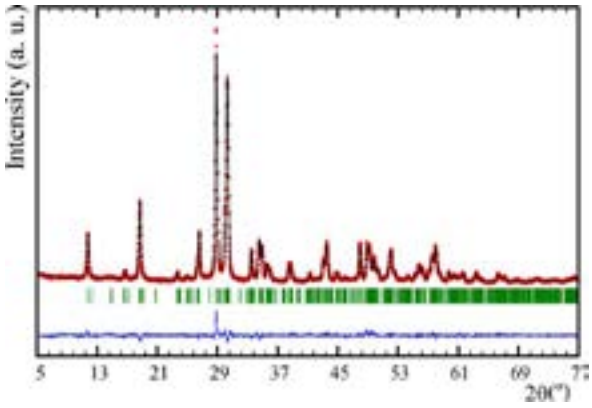

Figure 1:

Rietveld refinement of the cuspidine-related $Eu_4Al_2O_9$ phase (space group P21/c).

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Biography

Aroa Moran-Ruiz studied Chemistry at the University of the Basque Country (UPV/EHU) (2004-2009). She has completed a master´s in Forensic Analysis at UPV/EHU (2009-2010). In 2010 she joined to the research group of Prof. Maribel Arriortua at UPV/EHU. In 2012 Aroa was granted with a PhD fellowship by the University of the Basque Country. She was a 3 month PhD visiting student at the University of Birmingham (UK) under the supervision of Prof. Peter Slater. On June 2015 she finished his PhD studies (Inorganic Chemistry) at the UPV/EHU. Aroa is currently working as a postdoctoral researcher funded by the University of the Basque Country. She is working in several topics such as synthesis and characterization of rare earth oxides. She is habitual user of X-ray powder diffractometer. Aroa has experience in Synchrotron X-ray measurements and, structural analysis by Rietveld refinement. She has knowledge of X-ray photoelectron spectroscopy and Raman spectroscopy.

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FLUORESCENCE IN QUANTUM SYSTEMS WITH VIOLATED SYMMETRY

Nikolai N. Bogolubov[1] and **Andrey V.Soldatov**
Mathematical Institute of the RAS, Russia

The present study is devoted to investigation of radiative properties of N-level quantum systems driven by external semi-classical monochromatic high-frequency electromagnetic field and interacting with a heat bath simultaneously. In essence, one-electron multi-level atom model with violated symmetry was studied under the assumption that its transition dipole operator possesses permanent diagonal matrix elements and not all of them are equal to each other, which assumption amounts to the violation of the spatial inversion symmetry. A general formula for the intensity of the electromagnetic field radiated from such a system in the far-distant zone was derived which does not contain contributions stemming from these non-zero permanent diagonal matrix elements of the transition dipole moments explicitly [1]. Hence, it can be concluded that the dynamics of these diagonal matrix elements may affect the system fluorescence only indirectly through the alteration of the time dependence of the non-diagonal matrix elements due to quantum processes of higher orders. As an example, radiative properties of a monochromatically driven two-level quantum system with permanent non-equal dipole moment diagonal matrix elements were thoroughly analyzed. The time evolution of the atomic subsystem of the whole quantum system (i.e. the atom + heat bath) was described by the approximate master equation for the atomic reduced density operator. On its basis, a closed set of evolution equations for the time-dependent averages of some selected relevant subsystem variables and their correlation functions was deduced. The so obtained set of equations was analyzed and solved by means of the well-established technique [e.g. 4, 5]. Equations derived were solved numerically in the steady-state limit. Finally, the steady-state fluorescence spectrum was calculated and it was found that the radiative properties (spectrum) of this two-level atom with violated spatial inversion symmetry can be significantly modified compared to those of atoms without such violation. In particular, it was found that the system in question can radiate at essentially lower frequencies than the frequency of the driving field [2]. It is important to note that the system dynamics itself was studied not only numerically but also analytically, and the existence of a small parameter governing this phenomenon of the low-frequency radiation was revealed explicitly as a result. The central part of this work results are the (plausible) conditions under which a simple two-level quantum system driven by external semi-classical monochromatic high-frequency electromagnetic (laser) field can radiate continuously at much lower frequency. It was shown that this can be possible under certain conditions and was also discussed how such a system could be realized in practice. The absorption-amplification response to the weak probe field in a simple two-level quantum system with non-equal permanent diagonal transitional dipole moment matrix elements driven by semi-classical monochromatic field at resonant frequency was studied too [3]. It was found that this system is able to amplify low-frequency EM radiation for a broad enough range of frequencies. It is reasonable to assume that all the results mentioned above may be of use in various fields of nano-electronics and can be employed in development of practically useful devices dedicated for generation and amplification of relatively low-frequency (terahertz) EM radiation.

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Biography

Nikolai N. Bogolubov (Jr.) is a Chief Scientific Researcher at the V.A. Steklov Mathematical Institute of the RAS. His scientific interests are in general mathematical problems of equilibrium and non-equilibrium statistical mechanics and applications of modern mathematical methods of classical and quantum statistical mechanics to the problems of the polaron theory, superradiance theory, and the theory of superconductivity. His main works belong to the field of Theoretical and Mathematical Physics, Classical and Quantum Statistical Mechanics, Kinetic theory. He has published more than 150 works in the field of Statistical Mechanics, Theoretical and Mathematical Physics.

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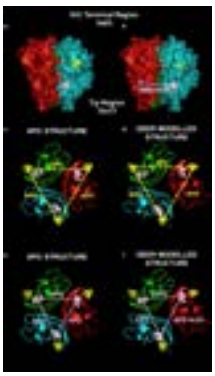
ANTIBODY-ENABLED SMALL MOLECULE DRUG DISCOVERY

Alastair Lawson
UCB, Slough, UK

Targeting protein-protein interactions with small molecules presents a number of well documented challenges, including the largely flat, featureless interfaces for many published structures. While structural information has undoubtedly assisted in drug discovery through suggesting direction and properties for compound elaboration, the guidance provided can only be truly valuable if the structure on which it is based is an accurate representation of the precise conformation of the protein being targeted. Crystal structures, although visually compelling, may not represent the biologically relevant conformation of the target, and can suffer from distortion due, for example, to intermolecular contacts in the lattice. Orthogonal biophysical techniques, such as Double Electron-electron Resonance (DEER), in conjunction with spin labeling at specified points on the surface of target proteins, can be used to probe natural conformational sampling, and provide distance measurements, which can be compared to those obtained from equivalent positions in crystal structures. Existing crystal structures may thus be adjusted, using advanced molecular dynamics simulations, to accommodate the distance measurements from DEER and create working models of target proteins in biologically relevant conformations. For example the image below shows how a crystal structure of apo TNF was adjusted using distance data from DEER, to generate a working model of a new conformation of the target, which may be helpful in drug discovery.



Recent Publications

1. Importance of Rigidity in Designing Small Molecule Drugs to tackle Protein-protein Interactions through stabilization of Desired Conformers. Lawson ADG; MacCoss M; Heer J. Journal of Medicinal Chemistry Doi 10.1021/acs.jmedchem.7b01120, 2017
2. Natural Conformational Sampling of Human TNFalpha Visualized by Double Electron-Electron Resonance. Carrington B; Myers WK; Horanyi P; Calmiano M; Lawson ADG. Biophysical Journal. 113(2):371-380, 2017
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7. Antibody-enabled small-molecule drug discovery. Lawson AD. Nature Reviews Drug Discovery. 11(7):519-25, 2012.

Biography

Alastair has been closely involved with the discovery of UCB/Celltech's therapeutic antibodies, including Mylotarg®, Besponsa®, Cimzia®, romosozumab, dapirolizumab pegol, olokizumab, bimekizumab and UCB7665. Alastair led the development of UCB's proprietary antibody variable region discovery platform, and is now applying structure-based, rational design to antibody discovery. He pioneered UCB's small molecule protein/protein interaction initiative, in which information derived from antibodies is applied to the discovery and design of new chemical entities. Current research interests include the use of function-modifying antibody fragments to define specific conformations of target proteins, linking X-ray crystallography, orthogonal biophysical techniques, molecular dynamics simulations and antibody technology to small molecule fragment screening

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CRYSTALCMP – FAST PACKING COMPARISON OF MOLECULAR CRYSTALS

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Institute of Physics, ASCR, Czech Republic

The crystal structure similarity is not an established and generally defined property. There are various definitions of crystal structure similarity defined for different purposes, each having different advantages and disadvantages in different situations. There are several methods, that define the similarity of crystal structures as a similarity of a representative functions called fingerprints [1]–[4]. These methods compare crystal structures indirectly, by comparison of their fingerprints. Other methods, are trying to compare atomic coordinates [5]–[8] or even positions of basic moieties in the crystal structures [9], [10]. In all cases, when differences in positions of atoms or moieties are used for calculation of the crystal structure similarity, the transformation between crystal structures has to be determined. The difficulty of this procedure is nicely described in [8]. CrystalCMP [11] is a software for comparison of molecular packing that was recently published. The suggested method is based on the second mentioned approach - comparison of molecular positions. It is immediately clear, that the comparison method is designed for all non-polymeric crystal structures, where some stand-alone moieties (molecular fragments) can be found. It is perfectly valid for all molecular crystals and some of the metal-organic complexes. Most of the inorganic structures and MOF with polymeric structures cannot be compared by this method. The comparison method is divided in several steps: (i) Definition of the central molecule (the largest molecule in the unit cell by default), (ii) creating of the molecular cluster (10 surrounding molecules by default), which is representing the whole crystal structure, (iii) definition of the fragment for overlaying (either by SMILES notation or by HASH strings as originally published in 2016) and (iv) overlapping molecular clusters according to the defined fragment and (v) calculating differences in molecular positions and its relative rotations, see definition of the Psab formula.

$$Ps_{a,b} = D_c + X \cdot \frac{A_d}{180}$$

where Dc is the average distance (in Å) between the molecular centers of related molecular pairs and Ad is the average angle (in degrees) between them. The X value is set by the user to weight the influence of the Ad parameter (the default value is X = 100), see Fig 1. As a result of comparison is a similarity matrix with calculated dendrogram and the transformation matrix between both compared molecular clusters. This enables overlaying the compared structures and see differences visually in human-readable form. The advantage of this method is its low sensitivity to the relatively large expansion of the molecular structure caused e.g. by the temperature or even by the presence of different solvent molecules in the crystal structure. For that reason this method is applicable for comparison of solvatomorphic series of identical or even just similar compounds. Several tests on different compounds had been performed. The algorithm compares two molecular packing in less than one second on a common office PC (approx. 100 ms for small molecule of benzamide and approx. 200 ms for middle-size molecule of trospium [11]). This allows making comparison of large number of compounds. In addition, automation of the method allows, for example, comparison of all crystal structures in the whole CSD database

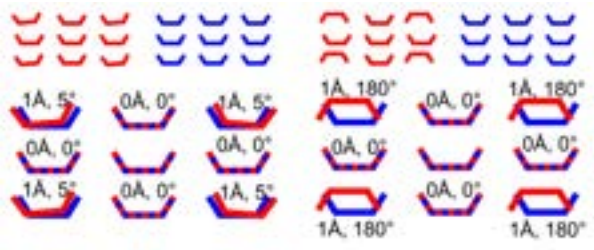

Figure 1 A graphical interpretation of the method used in CrystalCMP. (Top left and top right) In both cases the central molecules are surrounded by eight molecules. (Bottom) Both upper clusters are overlapped and the numbers near each surrounded molecule represent the differences in the molecular centers of related pairs and the angle differences between them. In general, these numbers are real. (Left) Two crystal structures with almost identical packing, Psab = 0.5 + 100 × (2.5/180) = 1.9 (for X = 100). (Right) Two crystal structures with almost identical positions of surrounding molecules, but with different packing of surrounding molecules, Psab = 0.5 + 100 × (90/180) = 50.5 (for X = 100).

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comparison of crystal structures," Acta Crystallogr. B, vol. 61, no. 1, pp. 29–36, Feb. 2005.

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Biography

Jan Rohlicek has his expertise in crystal structure determination from powder diffraction data. He is the author of a grid extension of program FOX, that is used for crystal structure determination from powders. He is also author of the program MCE (Marching Cule ELD) for placing atoms and fragments to the 3D Fourier maps and of the presented program CrystalCMP for comparison of molecular packing. He is responsible for the laboratory of powder diffraction at the Department of Structure Analysis at the Institute of Physics ASCR in Prague

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FRAG XTAL SCREEN FOR DIRECT CRYSTALLOGRAPHIC FRAGMENT SCREENING

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A major challenge in drug discovery is the identification of chemical moieties that specifically interact with a particular protein target. Traditionally, this was addressed by High Throughput Screening (HTS) however, recently "Fragment Screening" has become increasingly popular. In a Fragment Screen a set of small molecules ("fragments"), typically with MW < 300 Da and with low affinities, are evaluated for specific interaction with a target. Crystallography/X-ray diffraction shows not only whether a fragment binds to the protein but also where and how the binding occurs and is therefore the favored screening method [1-3]. Hit-fragments are subsequently chemically modified in several optimization/screening cycles until a high affinity lead structure is obtained (figure 1). Since such a fragmented approach allows screening of broader chemical space compared to large, distinct libraries, the hit rates of Fragment Screens are believed to be 10-1000x higher than those in traditional HTS [4].

The *Frag Xtal Screen* is a unique Fragment Screen designed for direct crystallographic screening: 96 different fragments, selected for high chemical diversity, high solubility and for being validated crystallographic hits of several protein targets, are spotted onto the wells of a crystallization plate. This screening plate is ready-to-use for crystal soaking experiments and offers an easy entry to fragment-based lead discovery (FBLD) by crystallographic screening.

Figure 1: Fragment-based lead discovery takes advantage of fragment evolution and linking. Small individual fragments with inherently low affinity but high efficiency are grown according to the structural model. The efficient binding of the fragments generates a lead structure in the nanomolar affinity range.

Recent Publications

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Biography

Christin studied Biotechnology and joined Jena Bioscience GmbH in 2005. She was promoted Head of Macromolecular Crystallography & Cryo-EM in 2011 and works in product development ranging from classic crystallization screens to specific tools and screens for Cryo-EM

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