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Scientific paper

Alumazene Reactivity with Quinolinols – Addition and Substitution Reactions on the Al_3N_3 Ring

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Abstract

Molecular structures of two compounds obtained in reactions of alumazene $[DippNAlMe]_3$ (**1**, Dipp = 2,6-*i*-$Pr_2C_6H_3$) with substituted quinolinols have been elucidated by the single-crystal X-ray diffraction analysis. Quinolin-8-ol (Hq) provides a dinuclear complex $[(DippNH)_2Al_2Me_2(q)_2]$ (**2**) with a central Al_2O_2 ring and five-coordinate Al atoms. The compound **2 · THF** crystallizes in the orthorhombic *Pbca* space group. The molecular structure of a mononuclear complex $[(DippNH)Al(Meq)_2]$ (**3**) obtained in the reaction of **1** with 2-methylquinolin-8-ol (HMeq) possesses a five-coordinate Al center. The structure was solved in a triclinic cell *P*–1. The dinuclear complex **2** can be considered as a model product of alcohol addition on the formal Al–N double bond, while the mononuclear complex **3** represents subsequent reaction of remaining Al–Me moiety with proton. Both complexes **2** and **3** are highly luminescent showing emission around 500 nm in solid state.

Keywords: Alumazene; crystal structure; quinolin-8-ol; 2-methylquinolin-8-ol; luminescence

1. Introduction

So far only two examples of synthetic procedures leading to cyclic trimeric iminoalane (alumazene-type) molecules were published. The first one is a two-step synthesis from trimethylaluminium and diisopropylaniline in toluene. Dimeric aminoalane formed in the initial step is transformed in the second step by heating to trimeric iminoalane $[DippNAlMe]_3$ (**1**, Dipp = 2,6-*i*-$Pr_2C_6H_3$).[1–3] The second route to an alumazene derivative is a one-pot reaction of $(Me_3Si)_3Al \cdot OEt_2$ with 2,6-diisopropylaniline. An adduct $[(Me_3Si)_3Al \cdot N(H)_2(Dipp)]$ is formed by coordination of the nitrogen lone pair to the Al center. Refluxing in toluene leads to the formation of $[DippNAlSiMe_3]_3$ (**4**).[4] Alumazene in comparison with its isoelectronic analogue benzene is not aromatic, its π electrons are not delocalized, and the Al-N bonds are highly polar.[5,6] Chemical reactivity of alumazene reflects this bonding situation. The Al atoms are Lewis acidic and are capable of accepting lone pairs of Lewis O- and N-bases. Several types of mono-, bis-, and trisadducts were reported in the literature.[7–11] Stepwise fluorination of alumazene **1** by Me_3SnF or by BF_3 represents metathesis reactivity leading to the substitution of the methyl groups on aluminium.[12] Dealkylsilylation reactions of **1** with trimethylsilyl esters of sulfonic, phosphoric, and phosphonic acids are another type of alumazene reactivity.[13,14] These reactions are driven by the formation of strong Al–O–P/S bonds and elimination of small molecules, such as $SiMe_4$. Although all bonds in the planar Al_3N_3 core of **1** are of the same length, the ring can undergo reactions that can be classified as an addition on a formal double bond. This type of transformations can be exemplified by reactions of **1** with silanetriols and isoelectronic triaminosilanes. Adamantane-like structures are formed in these reactions by triple proton transfer to the alumazene nitrogen atoms and connecting the three Al atoms to oxygens or nitrogens of the particular reagent. In the resulting molecules, alumazene ring lost its planarity and both Al and N atoms are four-coordinate.[15] Cyclopentadienyl Ti(IV) and Zr(IV) trifluorides react with **1** under fluorine-nitrogen exchange creating adamantane-like cage molecules.[16,17]

Quinolin-8-olate complexes of aluminium are widely investigated because they are suitable materials for use in organic light-emitting diodes (OLED). Metal complexes bearing quinolin-8-olato derivatives are applied as the emissive and electron transporting materials in electroluminiscent devices.[18–20] The most frequently used material is Al(quinolin-8-olate)$_3$ (Alq$_3$)[18] which has been carefully studied and its physico-chemical properties, such as refractive index[21,22] and absorption coefficient[23,24] have been measured.

Besides the tris(quinolin-8-olato) complexes, other types of ligand arrangement are sought as they provide a way to control emission wavelength. Bis(2,4-dimethyl-quinolin-8-olato)(triphenylsilanolato)aluminum was synthesized from aluminium iso-propoxide and two ligands, 2,4-dimethyl-quinolin-8-ol and triphenylsilanol. This complex with five-coordinate Al showed no glass temperature and no phase transition before the melting point and the thermally stable thin films could be easily formed.[25] The photoluminescence (PL) spectrum of the complex shows the largest hypsochromic shift among the blue-emitting [q$_2$AlOR]-type complexes. Some complexes of Al with polymerizable quinolin-8-olato ligands were used in a copolymerization reactions leading to products with good PL properties.[26] Two new complexes were prepared by the reactions between $AlCl_3 \cdot 6H_2O$ and 5,7-dichloro- or 5,7-dibromo-quinolin-8-ol providing homoleptic Al(ligand)$_3$ complexes.[27] Authors studied their electroluminescent properties. A series of 3-, 4-, and 5-methylquinolin-8-olate complexes of Al and Ga was prepared and the photo- and electroluminescence properties were examined.[28] Although methylation improved PL quantum efficiency, it also reduced intermolecular interactions and decreased charge transport through the film. Complexes of aluminium with 4-(2-arylvinyl)-quinolin-8-olates prepared by anhydrous Heck coupling with judicious choice of substituents display enhanced PL intensity and quantum yield.[29]

Quinolin-8-olate complexes of Al are also used as catalysts in the ring-opening polymerization (ROP). Mononuclear and dinuclear complexes with bulky 2-(arylimino)quinolin-8-ols were prepared. The dimeric complexes were obtained by the stoichiometric reaction of $AlMe_3$ with the corresponding ligands in *n*-heptane. These compounds are insoluble in *n*-heptane and only slightly soluble in toluene, THF, CH_2Cl_2, and $CHCl_3$. The stoichiometric reactions of appropriate ligands with $AlMe_3$ in toluene produce molecular compounds Me_2AlL and by-products $Me_2AlL \cdot AlMe_3$. The mononuclear complexes exhibit high activity towards the ROP reaction of ε-caprolactone in the presence of benzyl alcohol, while the dinuclear complexes exhibit no activity in this polymerization reaction.[30,31] The complexes of aluminium with quinoline-based N,N,O-tridentate and N,N,N-chelate ligands were used for ring-opening polymerization of ε-caprolactone. Complexes were prepared by simple mixing of ligand and $AlMe_3$ at room temperature in toluene.[32,33]

The aim of this research was to investigate the reactivity of alumazene **1** towards quinolinols as chelating ligands bearing an active proton and a nitrogen donor atom. The two ligands used in this study differ in their steric hindrance and we expected different products from their reactions. We present here the synthesis and characterization by single-crystal X-ray diffraction analysis of two complexes **2** and **3** displaying a different nuclearity and metal-to-ligand ratio.

2. Experimental

2. 1. General Procedures and Characterization

All manipulations were performed under a dry nitrogen atmosphere by Schlenk techniques or in MBraun Unilab dry box maintained under 1 ppm of both O_2 and H_2O. Solvents were stored and handled under nitrogen atmosphere in a glovebox or in Schlenk flasks. Melting points were measured on a Buchi B540 apparatus in glass capillaries sealed in glovebox. The IR spectra (4000–400 cm^{-1}) were recorded on a Bruker Tensor T27 spectrometer. Samples were prepared as KBr pellets. EI-MS measurements were performed on a TSQ Quantum XLS mass spectrometer. Solid samples of **2** and **3** were introduced into the spectrometer via direct insertion probe (DIP) in open quartz capillaries and heated from r. t. to 450 °C. The source temperature was set to 200 °C and ionization energy to 22 eV. Aluminium contents were determined on an ICP optical emission spectrometer iCAP 6500 Duo (Thermo, UK) equipped with a solid-state generator with a frequency of 27.12 MHz and a maximum power input 1350 W. The measurements of Al were performed at 308.2, 394.4 and 396.1 nm with RF power of 1150 W; analysis pump rate 1 cm^3 min^{-1}; nebulizer gas flow 0.65 dm^3 min^{-1}; coolant gas flow 12 dm^3 min^{-1}; auxiliary gas flow 0.6 dm^3 min^{-1}; flush time 30 s; flush pump rate 2 cm^3 min^{-1}; pump stabilization time 5 s; integration time (high WL range) 5 s; the number of repeats 3; plasma view radial.

2. 2. Reagents

Quinolin-8-ol (Hq, Aldrich, 99 %) and 2-methylquinolin-8-ol (HMeq, Aldrich, 98 %) were dried under dynamic vacuum for 2 d prior to use. Solvents were dried over and distilled from Na/benzophenone under nitrogen. Solvents were degassed prior to use. Alumazene **1** was prepared by a modified procedure from $AlMe_3$ and 2,6-diisopropylaniline.[3]

2. 3. Synthesis of 2

Quinolin-8-ol (0.023 g, 0.16 mmol) was added to the solution of **1** (0.1045 g, 0.1603 mmol) in dry deoxygenated heptane (1 mL). THF (5 mL) was added and the reaction mixture was stirred for 2 h. The reacting mixture was concentrated to ¼ of its starting volume and stored at –25 °C.

After six months, colorless crystals were obtained. The crystals for the X-ray diffraction analysis were used directly from the mother liquor. Yield: Crystals 0.013 g, 5.5 %, polycrystalline powder 0.140 g, 73 %. Melting point: 247 °C.

EI DIP MS (22 eV): *m/z* (int. %) 651.84 (10) [M – *i*-Pr – $2CH_3$]$^+$; 460.74 (40) [M – Dipp – *i*-Pr – $4CH_3$]$^+$; 333.73 (30) [M – Dipp – *i*-Pr – $4CH_3$ – C_9H_6N]$^+$; 314.90 (90) [M – Dipp – *i*-Pr – $4CH_3$ – C_9H_6NO]$^+$; 282.49 (70); 184.03 (100); 144.95 (100) [C_9H_7NO]$^+$.

Elemental analysis: Al% Calcd. for $C_{48}H_{62}N_4O_3Al_2$ 6.77. Exp. 6.44 ± 0.03.

IR (cm^{-1}): ν 3046 w, 2961 w, 2928 w, 2865 w, 1065 m, 1058 m, 1499 vs, 1470 s, 1385 vs, 1330 m, 1283 w, 1230 w, 1115 m, 1033 w, 825 m, 805 m, 789 m, 749 s, 649 m, 549 m, 457 w, 419 m.

2. 4. Synthesis of 3

2-methylquinolin-8-ol (0.024 g, 0.15 mmol) was added to the solution of **1** (0.119 g, 0.183 mmol) in dry deoxygenated THF (5 mL). The reaction mixture was concentrated to ¼ of its starting volume and stored at –25 °C. The colorless crystals for the X-ray diffraction analysis were used directly from the mother liquor. Yield: Crystals 0.028 g, 10 %, polycrystalline powder 0.194 g, 68 %. Melting point: 214 °C.

EI DIP MS (22 eV): *m/z* (int. %) 343.01 (77) [M – HNDipp]$^+$; 176.92 (55) [HNDipp]$^+$; 161.86 (100) [Dipp]$^+$.

Elemental analysis: Al% Calcd. for $C_{32}H_{34}N_3O_2Al$ 5.19. Exp. 5.15 ± 0.05.

IR (cm^{-1}): ν 3053 m, 2962 s, 2926 m, 2867 w, 1613 m, 1578 vs, 1508 vs, 1465 vs, 1432 vs, 1432 vs, 1394 m, 1341 m, 1332 w, 1274 vs, 1262 s, 1243 w, 1171 w, 1114 vs, 1018 s, 869 w, 829 s, 795 s, 772 vs, 741 s, 688 m, 675 s, 530 m, 435 w.

2. 5. X-Ray Structure Determination

Diffraction data were collected using a Rigaku X-ray diffraction system, equipped with a MicroMax007HF double wavelength rotating anode X-ray source (λ = 0.71075 Å, Mo radiation), VariMax DW optics, a partial χ axis geometry goniometer, a Saturn 724+ HG CCD detector and a Cryostream cooling device. *CrystalClear*[34] software was used for data collection.

Processing of diffraction images was carried out using *CrysAlisPro.*[35] *SHELXT* and *SHELXL* programs[36] were used to solve and refine models (full matrix least-squares refinement on F^2). All non-hydrogen atoms were refined anisotropically. ADPs of nitrogen bonded hydrogen atoms were set to 1.2 U_{eq} of carrier atoms, and respective N–H distances were restrained to 0.88 Å. All other hydrogen atoms were placed to the calculated positions and refined as riding (CH_3 hydrogens also rotating), with their U_{iso} val-

Table 1. Crystal data and structure refinement summary

Compound	**2 · THF**	**3**
Empirical formula	$C_{48}H_{62}Al_2N_4O_3$	$C_{32}H_{34}AlN_3O_2$
Formula weight	796.97	519.60
Temperature (K)	120(2)	120(2)
Crystal system	orthorhombic	triclinic
Space group	*Pbca*	*P*–1
a (Å)	18.4340(2)	9.25960(10)
b (Å)	19.5025(2)	12.05340(10)
c (Å)	24.8159(3)	13.09420(10)
α (°)	90	97.9350(10)
β (°)	90	97.0130(10)
γ (°)	90	109.2860(10)
Volume (Å^3)	8921.54(17)	1344.06(2)
Z	8	2
ρ_{calc} (g/cm^3)	1.187	1.284
μ (mm^{-1})	0.110	0.110
F(000)	3424.0	552.0
Reflections collected	52737	16096
Independent reflections (R_{int}, R_{sigma})	8470 (0.0201, 0.0102)	5048 (0.0136, 0.0123)
Data / restraints / parameters	8470 / 244 / 576	5048 / 1 / 352
Goodness-of-fit on F^2	1.017	1.037
Final *R* indices [$I \geq 2\sigma(I)$]	$R_1 = 0.0442$ $wR_2 = 0.1171$	$R_1 = 0.0358$ $wR_2 = 0.0940$
Final *R* indices [all data]	$R_1 = 0.0477$ $wR_2 = 0.1205$	$R_1 = 0.0385$ $wR_2 = 0.0962$
Largest diff. peak / hole (e Å^{-3})	0.47/–0.31	0.32/–0.27

ues set to 1.2 U_{eq} (1.5 U_{eq} for methyl hydrogens) of respective carrier atoms. Positionally disordered fragments were treated by geometric restraints, ADP similarity restraints and rigid bond restraints. In these cases, the sum of site occupancy factors was fixed to be equal to 100 %. Relevant crystallographic data are shown in Table 1.

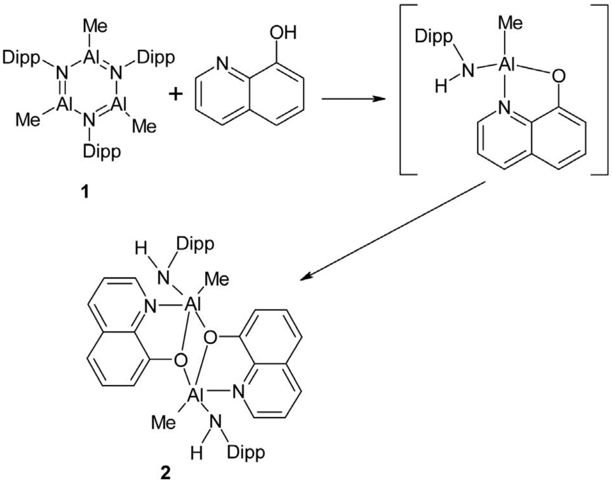
2. 6. Luminescence Measurements

Samples of **2** and **3** were prepared as powders in quartz capillaries (4 mm diam.) and as dilute solutions (0.719 mol l^{-1} for **2** and 0.718 mol l^{-1} for **3**) in CH_2Cl_2. Emission and excitation spectra were measured by steady-state fluorescence spectroscopy on the Aminco Bowman Series 2 spectrofluorometer equipped with 150 W Xe lamp. Excitation monochromator was set at 370 nm for both samples. Emission monochromator was set at 502 nm for sample **2** and 497 nm for sample **3**. Quantum yields were estimated using secondary method with quinine bisulphate in H_2SO_4 as a luminescence standard. Luminescence lifetimes were measured by time correlated single photon counting instrument SPC130EM (Becker and Hickl GmbH) equipped with 408 nm laser diode (picosecond resolution, repeating frequency 150 MHz). All luminescence measurements were recorded at 25 °C.

3. Results and Discussion

3. 1. Synthesis

The compound **2** was prepared as yellow air- and moisture-sensitive crystals, by the reaction of alumazene **1** with quinolin-8-ol in the 1:1 molar ratio (Scheme 1). In the first step quinoline adds at a formal Al-N double bond in **1**. Trimeric iminoalane ring structure is destabilized and intermediate substituted aminoalane is probably formed. This intermediate dimerizes and aluminium atoms are connected by oxygen bridges to form the central Al_2O_2 ring. Aluminium coordination number increases to five by bonding to quinoline nitrogen.

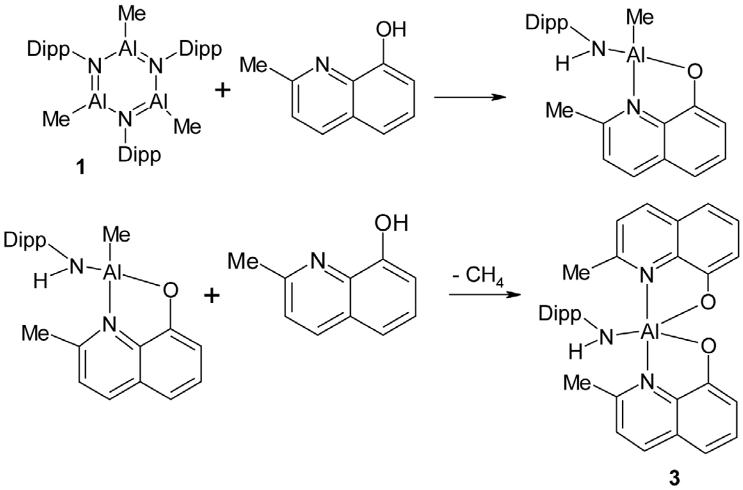


Scheme 1

The compound **3** was prepared as air- and moisture-sensitive colorless crystals, by the reaction of **1** with 2-methylquinolin-8-ol in the 1:1 molar ratio (Scheme 2). The first step of the reaction proceeds as in the previous case and 2-methylquinolin-8-ol adds at the formal Al-N double bond in alumazene **1**. However, in the second step the intermediate aminoalane reacts with the second molecule of 2-methylquinolin-8-ol by the proton transfer to the methyl group and CH_4 is eliminated. The resulting molecule is monomeric and the coordination number of aluminium atom is increased to five by coordination of two quinolinol nitrogens.

3. 2. Crystal Structures

Single crystals of **2** suitable for the X-ray diffraction analysis were grown from the mother liquor. The molecular structure is displayed in Figure 1, selected interatomic



Scheme 2

distances and angles are listed in Table 2. Molecules of **2** crystallize in the orthorhombic space group *Pbca*. Bonds between aluminium and oxygen atom are longer in comparison with oxoaminoalumosilicates $[NH(Dipp)MeAl]_3O_3SiR_1$ with adamantane-like structure, where the Al–O bond distance is 1.74–1.75 Å. Also the bond between aluminum and nitrogen is in comparison with **1** (1.78 Å) elongated to 1.84 Å. The Al–N bond to quinolinol is 2.09 Å long and it is comparable with other donor-acceptor bonds in alumazene–nitrile adducts and in alumazene–pyridine adducts. The Al–C bond as well N–C bond are similar to starting alumazene **1**.[8,15,37] The aluminium atom is five-coordinate and its coordination environment lies between trigonal bipyramidal and tetragonal pyramidal shape (τ = 0.53). All nitrogen atoms have coordination number three, as is the case for bridging oxygen atoms. One molecule of solvent tetrahydrofurane (THF) cocrystallizes within the structure. Packing in the unit cell of **2** is shown in Figure 2.

Suitable single crystals of **3** for the X-ray diffraction analysis were grown from the mother liquor. The molecular structure is displayed in Figure 3, selected interatomic distances and angles are listed in Table 3. Molecules crystallize in the triclinic space group *P*–1. The Al–O bonds are shorter than in **2**, but longer than Al–O bonds in oxoaminoalumosilicates $[NH(Dipp)MeAl]_3O_3SiR_1$ (1.74–1.75 Å). The Al1–N41 bond is comparable to **2** but it is longer in comparison with **1** (1.78 Å). The other Al–N bonds are 2.08 Å long and they are comparable with Al–N in other alumazene-nitrile and alumazene-pyridine adducts. The coordination number of aluminium is five and its environment is close to trigonal bipyramidal (τ = 0.76).[8,15,37] Packing in the unit cell of **3** is shown in Figure 4.

Table 2. Selected interatomic distances and angles of **2 · THF**

Distances (Å)					
Al1–N3	1.8368(13)	O1–C10	1.3512(17)	Al2–N2	2.1195(13)
Al1–O1	1.8921(11)	N3–C21	1.4112(18)	Al2–C2	1.9647(18)
Al1–O2	1.9516(11)	Al2–N4	1.8283(13)	O2–C19	1.3572(18)
Al1–C1	1.9653(17)	Al2–O1	1.9769(10)	N4–C33	1.4196(18)
Al1–N1	2.0864(13)	Al2–O2	1.8778(12)		

Angles (°)			
O1–Al1–N3	113.80(6)	O2–Al2–N4	116.87(6)
O1–Al1–O2	73.85(5)	O2–Al2–O1	73.57(4)
O1–Al1–N1	80.01(5)	O2–Al2–N2	79.41(5)
O1–Al1–C1	118.68(6)	O2–Al2–C2	117.54(7)

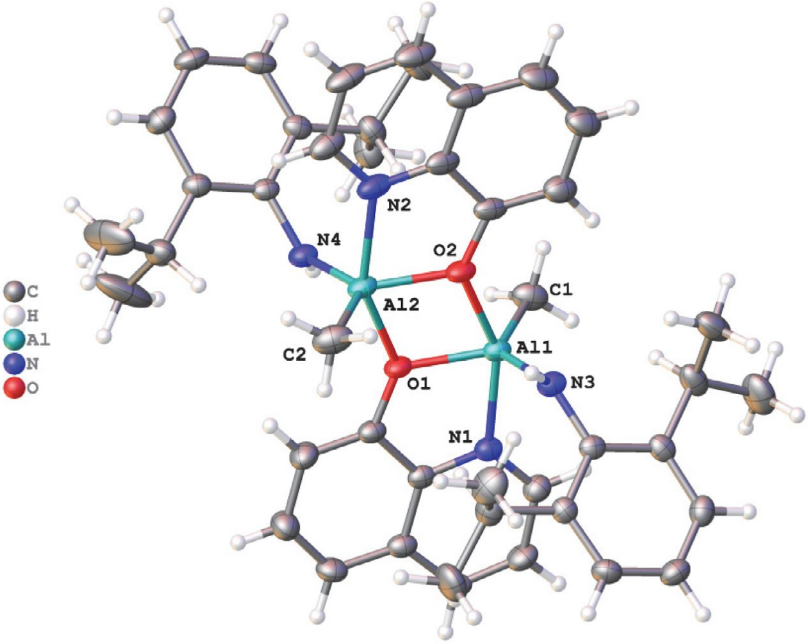


Figure 1. Thermal ellipsoid plot of **2** (disordered solvent molecule was omitted for clarity)

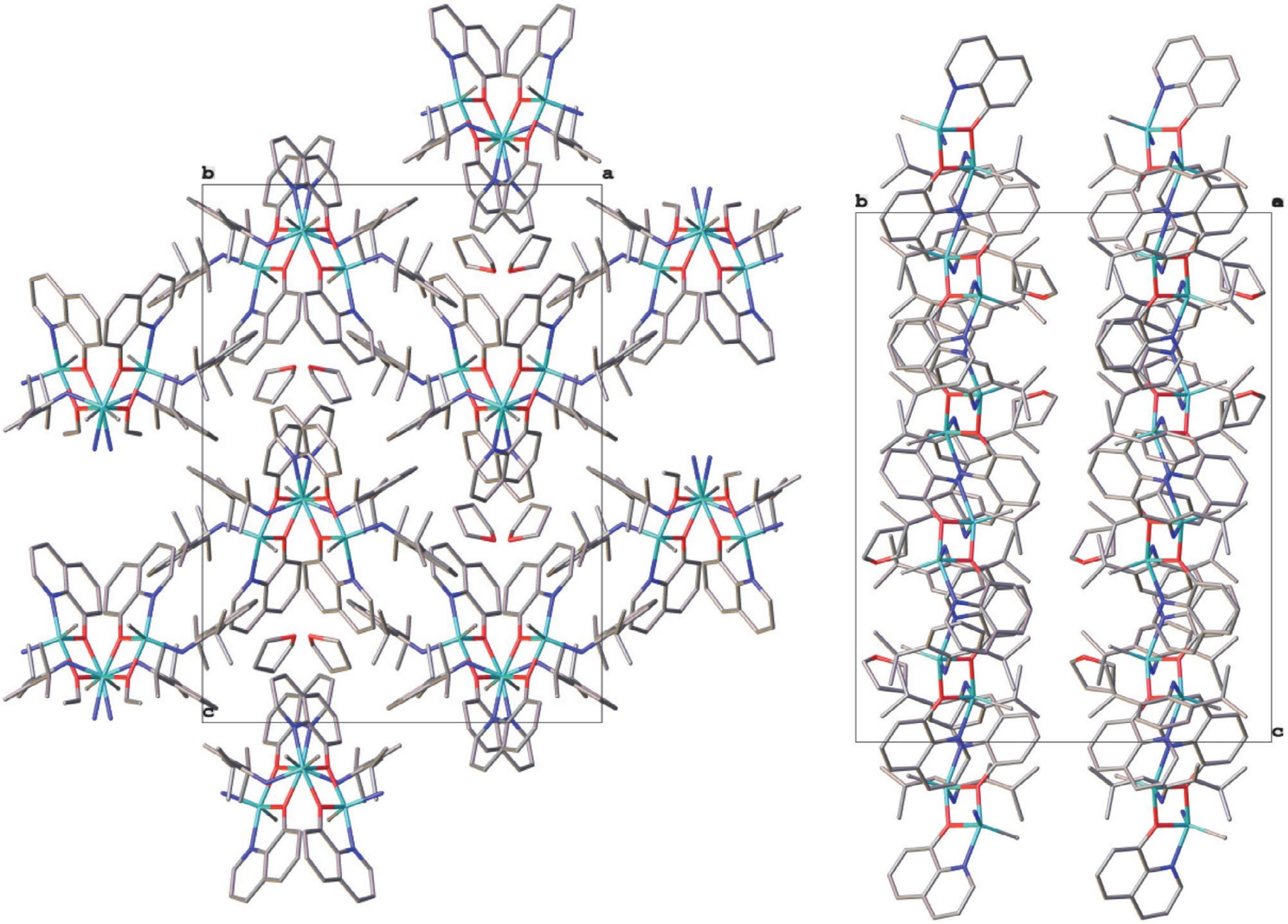


Figure 2. Packing in the unit cell of **2**, viewed along *b*-crystallographic axis (left) and *a*-crystallographic axis (right), hydrogen atoms were omitted for clarity

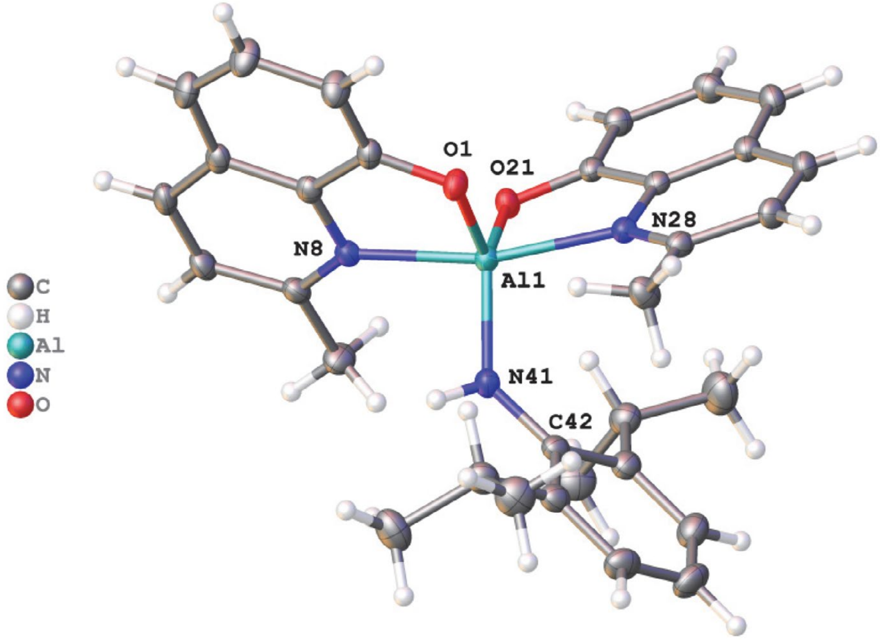


Figure 3. Thermal ellipsoid plot of **3**

Table 3. Selected interatomic distances and angles of **3**

Distances (Å)					
Al1–N8	2.0784(11)	Al1–O21	1.8039(9)	Al1–O1	1.8034(9)
Al1–N28	2.0782(11)	Al1–N41	1.8301(11)	N41–C42	1.4057(16)

Angles (°)			
O1–Al1–N8	83.78(4)	O1–Al1–N28	89.93(4)
O1–Al1–O21	116.08(4)	O1–Al1–N41	119.44(5)

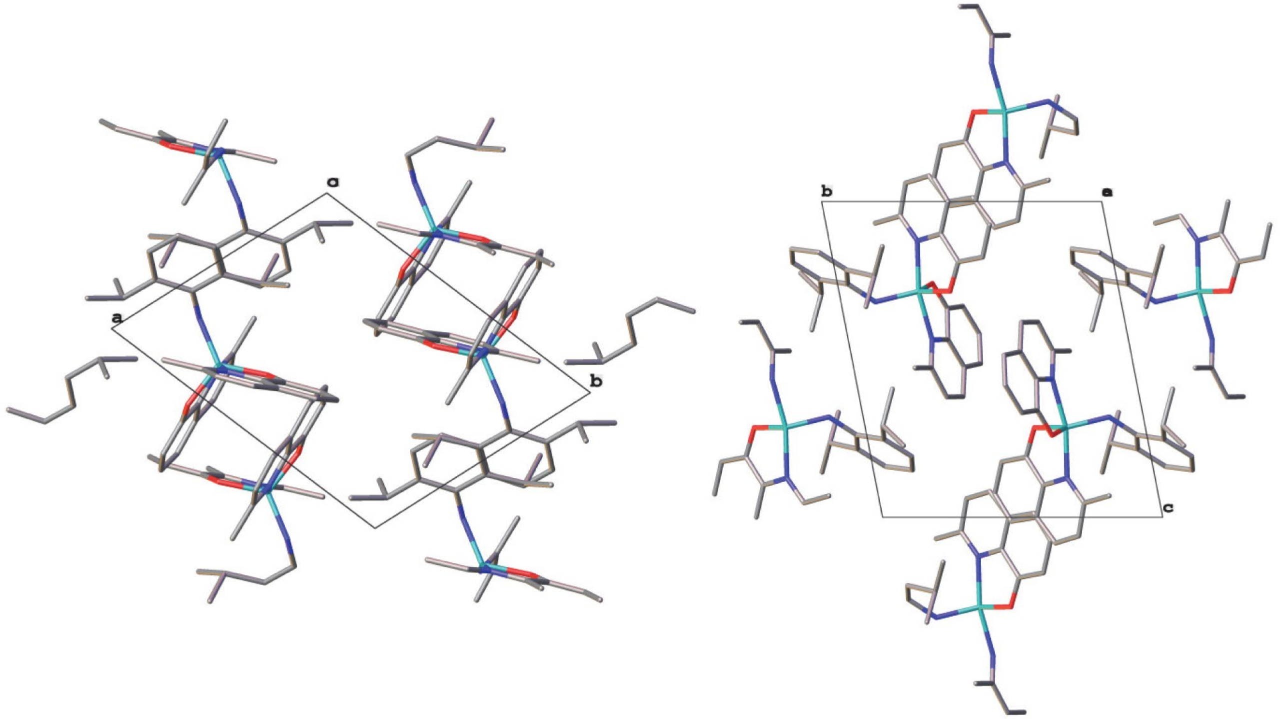


Figure 4. Packing in the unit cell of **3**, viewed along *c*-crystallographic axis (left) and *a*-crystallographic axis (right), hydrogen atoms were omitted for clarity

3. 3. Luminescence Properties

Emission spectra display maxima at 502 nm for **2** and at 497 nm for **3** in solid state (Figure 5). The excitation spectrum of **2** in solid state has shown a wide absorption region (300–450 nm) with maximum around 370 nm while the spectrum of diluted solution of **2** (in CH_2Cl_2) is shifted to higher wavelengths showing several maxima (375, 450, 465 nm). The excitation spectrum of **3** in solid state has maximum also around 370 nm whereas diluted solution of **3** shows at least two distinct peaks (372 and 446 nm). Emission maxima of complexes diluted in CH_2Cl_2 were slightly shifted to shorter wavelengths (500 nm for complex **2**, respectively 481 nm for complex **3**). Luminescence quantum yields were estimated using secondary method. We have used quinine bisulphate as a standard. Quantum yield of complex **2** was found to be 0.29 whereas **3** displays a yield of only 0.12. Luminescence lifetime of diluted complex **2** was found to be about 17 ns (Figure 6).

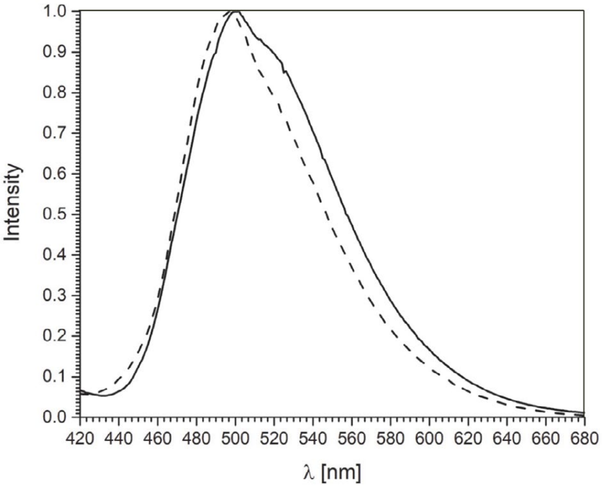


Figure 5. Normalized corrected emission spectra of **2** (solid) and **3** (dashed) complexes in solid state

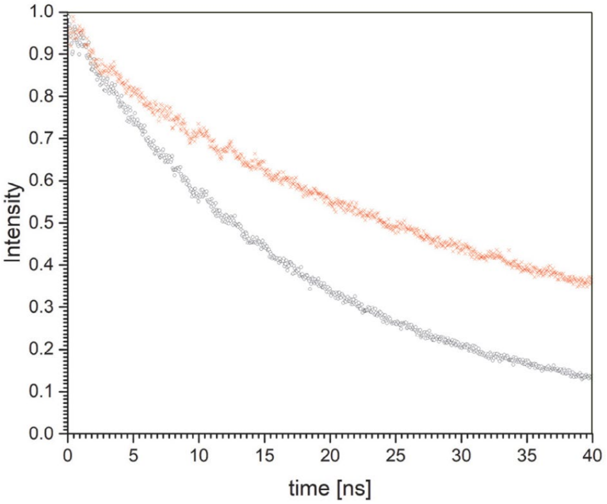


Figure 6. Lifetime measurement of **2** (bottom trace) and **3** (upper trace)

Lifetime of complex **3** was measured to be significantly longer (27 ns).

4. Conclusions

New crystalline complexes **2** and **3** were prepared and structurally characterized. The alumazen ring **1** behaves in these reactions as a structure with alternating double and single Al–N bonds, although the calculations predict that the free electron pair is localized at the nitrogen atom and delocalization energy is minimal in comparison to benzene.[5,6,38] Previous reactions of alumazene (**1**) were designed as reactions with N- or O-bases.[7-10] In the present case we use the ligands with the N-donor site and the acidic OH group. The proton is transferred to alumazene imidic nitrogen. In both **2** and **3**, the oxygen and nitrogen ligand atoms are coordinated to the aluminium in chelating fashion. Although the used quinolinols differ only in one Me substituent, the final products are quite different. It is well know that the Me group in position 2- on the pyridine ring hinders the formation of tris complexes.[19] The first step of both reactions is identical, addition to a formal Al–N double bond and deoligomerization of the trimeric Al_3N_3 ring. In the second step in the case of complex **2**, dimerization of an intermediate occurs, while in the case of **3**, an intermediate undergoes substitution reaction of the remaining Me group at aluminium atom and the monomeric product is formed. Both **2** and **3** are interesting precursors for the synthesis of a series of derivatives as they still possess reactive moieties, Al–CH_3 and Al–NH–Dipp, capable of further reactions with protic reagents, such as alcohols, silanols, and carboxylic acids. Both complexes (**2** and **3**) have relatively high luminescence quantum yields and show greenish-blue (cyan) emission in the solid state. The described complexes may open routes to the development of cyan-light-emitting OLEDs using subtractive colour systems (or subtractive CMYK systems).

5. Acknowledgements

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6. Supplementary Material

The crystallographic data of the structures described in this paper were deposited with the Cambridge Crystallographic Data Centre as supplementary publication no. CCDC-1850453 (**2**) and 1850454 (**3**). Copies of these data are available free of charge from http://www.ccdc.ac.uk/conts/retrieving.html, or from the Cambridge Crystallographic Data Centre, 12 Union Road, Cambridge CB2 1EZ, UK; fax: (+44)1223-336-033; or email: deposit@ccdc.cam.ac.uk.

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Povzetek

S pomočjo monokristalne rentgenske difrakcije smo določili strukturi dveh spojin dobljenih z reakcijo alumazena [DippNAlMe]$_3$ (**1**, Dipp = 2,6-*i*-Pr$_2$C$_6$H$_3$) z dvema kinolinoloma. Kinolin-8-ol (Hq) tvori dvojedrni kompleks [(DippNH)$_2$Al$_2$Me$_2$(q)$_2$] (**2**) z osrednjim Al$_2$O$_2$ obročem in petkoordiniranima Al atomoma. Spojina **2 · THF** kristalizira v ortorombski *Pbca* prostorski skupini. Molekulska struktura enojedrnega kompleksa [(DippNH)Al(Meq)$_2$] (**3**) izoliranega pri reakciji **1** z 2-metilkinolin-8-olom (HMeq) ima petkoordiniran Al center. Struktura je bila rešena v triklinski celici *P*–1. Dvojedrni kompleks **2** lahko obravnavamo kot modelni produkt adicije alkohola na formalno Al–N dvojno vez, medtem ko enojedrni kompleks **3** predstavlja primer nadaljnje pretvorbe preostale Al–Me skupine s protonom. Oba kompleksa **2** in **3** imata močno luminiscenco z emisijo okoli 500 nm v trdnem stanju.