Gmelin Handbuch der Anorganischen Chemie

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8th Edition

U
Uranium

Supplement Volume E2

Coordination Compounds

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Uranium

Supplement Volume E2

Coordination Compounds
(including Organouranium Compounds)

With 56 Illustrations

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INDEX OF LIGANDS

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Preface

This volume, the second on uranium coordination compounds, treats both non-solvated coordination compounds with non-neutral ligands and organometallic compounds.

Most of the coordination compounds are formed from U^{VI}, specifically from UO_2^{2+}. A smaller number are formed from U^{IV}. Information about possible U^{III} and U^{V} compounds is quite fragmentary. Investigators have shown special interest in UO_2^{2+} compounds with Schiff bases and, to a lesser extent, in compounds with 1,3-diketones although this interest has been largely qualitative rather than quantitative. That is to say these compounds, for the most part, have only been prepared and analyzed, without a more precise description of their properties.

In the case of organometallic compounds, the situation is somewhat different. Relatively few such compounds are known, but for the most part they are characterized with precise physical-chemical data (e.g. structure, molecular symmetry, magnetic properties, and spectrography results).

The literature has been reviewed to the end of 1977. Much work subsequent to 1977 has also been included.

The Index of Ligands, starting on p. 177, provides ready access to the uranium complex compounds and organouranium compounds in both "Uranium" Suppl. Volumes E1 and E2.

The Index is divided into three tables:

1. Formula Index of Ligands in Uranium Complexes.
2. Formula Index of Ligands in Organouranium Compounds.
3. Alphabetical Index of Ligands.

I wish to thank Prof. K. W. Bagnall (Manchester) and Prof. B. Kanellakopulos (Karlsruhe), the authors of the respective parts of this volume, for their excellent cooperation. Similar cooperation was shown by Gmelin Institute an especially by its Director Prof. Dr. Margot Becke and by its Editor-in-Chief Dr. Karl-Christian Buschbeck who personally edited this volume.

Karlsruhe
January 1980

Cornelius Keller

Vorwort

Der vorliegende zweite Band über Koordinationsverbindungen des Urans befaßt sich mit solvatfreien Koordinationsverbindungen nicht-neutraler Liganden und mit den metallorganischen Verbindungen.

Die Mehrzahl der Koordinationsverbindungen wird von U^{VI} als UO_2^{2+} gebildet, eine geringere Zahl von U^{IV}, während die Kenntnisse von möglichen Verbindungen mit U^{III} und U^{V} sehr lückenhaft sind. Besonderes Interesse wurde hierbei den Verbindungen des UO_2^{2+} mit Schiff'schen Basen und in geringerem Umfang mit 1,3-Diketonen gewidmet, allerdings meist nur in sehr qualitativer und weniger in quantitativer Weise, d.h. die Verbindungen wurden meist nur dargestellt und analytisch charakterisiert, ohne Beschreibung ihrer Eigenschaften.

Bei den metallorganischen Verbindungen ist die Situation anders. Es existieren nur relativ wenige Verbindungen, die aber in ihrer Mehrzahl mit genauen physikalisch-chemischen Daten (z.B. Struktur, Molekülsymmetrie, Magnetismus, spektroskopischen Befunden) charakterisiert werden.

Die Literatur ist bis Ende 1977 berücksichtigt, häufig sind auch noch neuere Arbeiten mit aufgenommen worden.

Den Zugang zu den Uran-Komplexverbindungen und den Uranorganischen Verbindungen in den beiden Bänden "Uranium" Suppl. Vol. E 1 and E 2 soll der „Index of Ligands" erleichtern (ab S. 177).

Er besteht aus drei Teilen:

Formula Index of Ligands in Uranium Complexes
Formula Index of Ligands in Organouranium Compounds
Alphabetical Index of Ligands.

Herrn Prof. Dr. K. W. Bagnall (Manchester) und Herrn Prof. Dr. B. Kanellakopulos (Karlsruhe), den Autoren der genannten Kapitel, danke ich für die ausgezeichnete Zusammenarbeit. Diese sehr gute Zusammenarbeit ergab sich auch mit dem Gmelin-Institut, besonders mit ihrem Direktor, Frau Prof. Dr. Becke und Herrn Dr. Buschbeck als verantwortlichem Redakteur.

Karlsruhe
Januar 1980

Cornelius Keller

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1.2 Complexes with 1,3-Diketones and Related Ligands

Complexes with 1,3-Diketones and Related Ligands

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The complexes formed by 1,3-diketones, ketoaldehydes, ketoesters and ketoamides are discussed in this section together with aromatic compounds, such as 2-hydroxybenzaldehyde (= salicylaldehyde) and esters of 2-hydroxybenzoic acid (= salicylic acid), which behave as the enolic forms of unknown 1,3-diketones. Violuric acid derivatives in the nitrosoenolic form also show some resemblance to 1,3-diketones and 1-oxa-4-methyl-8-amino-7-hydroxynaphthalene-2-one, although not strictly a β-ketoamide, is included here with other coumarin derivatives which fall into the 1,3-diketone category as a matter of convenience. Ligands such as 1-hydroxyxanthone, 4-methyl-7,8- or 6,7-dihydroxycoumarin and dimethyldiisooxazolone do not behave as 1,3-diketones and are discussed in the chapter on alkoxides (which will appear in a later "Uranium" Suppl. Vol.).

The uranium(IV) and dioxouranium(VI) acetylacetonates, $U(acac)_4$ and $UO_2(acac)_2 \cdot H_2O$, were among the earliest known uranium complexes. Their preparation in 1904 [1] appears to have attracted little interest, and it was not until the 1939/45 war that a major study of uranium complexes with this type of ligand was undertaken, the objective being a search for volatile uranium compounds which might prove suitable for the separation of ^{235}U from ^{238}U. These studies led to the isolation of a wide range of uranium chelates, the number of which has increased substantially in the last 30 years.

Ethanol and other solvates of chelate complexes of this type have been discussed earlier in the sections dealing with the complexes formed by the solvating ligands and are not considered further in this section.

1.2.1 1,3-Diketones

1,3-Diketones

The known complexes, with physical data where available, are listed in Table 1/60 and crystallographic data are given in Table 1/61; the method of preparation is also indicated in Table 1/60 (see A to J, below and continuing on p. 8).

1.2.1.1 Preparative Methods

Preparative Methods

The uranium(IV) chelates are very readily oxidised to the dioxouranium(VI) complex so that exposure to air during the preparations detailed below must be avoided [12]. The compounds are best prepared under nitrogen [33].

The most usual method (A) of preparing the uranium(IV) and (VI) chelates, UL_4 and UO_2L_2, is by treating an aqueous or ethanolic solution of a uranium salt with the 1,3-diketone, followed by the addition of aqueous sodium or potassium hydroxide [4, 146] to precipitate the complex, a procedure used in the first preparation of $U(acac)_4$ [1]. $NaHCO_3$ and Na_2CO_3 have also been used in place of NaOH [12, 13, 84, 136]. In some cases pyridine is used to adjust the

Table 1/60
Complexes with Diketones, $RCOCH_2COR'$. Capital letters indicate method of preparation, see pp. 1,8.
For diketonate complexes with additional neutral ligands such as pyridine or ethanol see „Uranium" Suppl. Vol. E1.

$CH_3COCH_2COCH_3 = C_5H_8O_2$ = Hacac, acetylacetone, pentane-2,4-dione	
$U(acac)_4$	brown to olive-green (A) [1], greenish-brown (B) [33], olive-green (D) [11], green (F) [37, 47], (G) [45]; m.p. 173° C (F) [32], 175° C [11], 175 to 176° C (A) [12], 176° C [1, 45], 177° C [2] (but d. >165° C [2]); subl. 190° C/10^{-4} Torr [11]; vapor pressure 9.1×10^{-3} Torr/130° C [12]; $\nu_{U-O(C)}$, 221 cm^{-1} *) [33], 398 to 400 or 220 cm^{-1} *) [36]
$U(acac)_2(C_{16}H_{14}N_2O_2)$	greenish-yellow (F) [150]
$C_{16}H_{16}N_2O_2 = (2\text{-}OH)C_6H_4CH:N(CH_2)_2N:CHC_6H_4(2\text{-}OH)$	
$U(OC_2H_5)_4(acac)$	brown viscous liquid, b. p. 118 to 121° C/0.55 Torr (H) [48]
$U(OC_2H_5)_3(acac)_2$	red-brown (H) [48]
$U(OC_2H_5)_2(acac)_3$	orange or yellow-brown (H) [48]
$U(O\text{-}t\text{-}C_4H_9)_4(acac)$	orange (J) [48]
$U(O\text{-}t\text{-}C_4H_9)_3(acac)_2$	yellow, subl. 195 to 210° C/0.1 Torr (J) [48]
$U(O\text{-}t\text{-}C_4H_9)_2(acac)_3$	orange-yellow (J) [48]
$UO_2(acac)_2$	(B) [69], (F) [114]; yellow-orange or yellow (A) [73], orange to orange-yellow (C) [54], orange [67, 103]; m. p. 220 to 222° C (sealed tube) [103], 225 to 250° C (A) [12], d. 230 to 235° C [54]; $\nu_{as,OUO}$, 923, (945?) cm^{-1} [73], 924 to 926 cm^{-1} [67], 928 cm^{-1} [108]; $\nu_{U-O(C)}$, 433 cm^{-1} *) [79]
$UO_2(acac)_2 \cdot H_2O$	(C) [106]; orange-yellow (A) [1, 13], α, α', β, yellow; γ, red [67]; $\nu_{as,OUO}$, 922 cm^{-1} (E) [108], 910 to 925 cm^{-1} [65, 66], 917 cm^{-1} (α, α'), 925 cm^{-1} (β), 905 cm^{-1} (γ) [67]; $\nu_{s,OUO}$, 840 cm^{-1} [65, 66]; $\nu_{U-O(C)}$, 421 cm^{-1} *) [79]; also [83]
$UO_2(acac)_2 \cdot 1.5\ H_2O$	[71]
$UO_2(acac)_2 \cdot$ Hacac	orange [67]; also [85]
$UO_2[Pt(acac)_2Cl]_2$	[93]
$CH_3COCH_2COC_2H_5 = C_6H_{10}O_2$, hexane-2,4-dione	
$U(C_6H_9O_2)_4$	m. p. 59 to 60° C (A) [12], 63° C (A) [13]; subl. 142° C/2 $\times 10^{-4}$ Torr [13]; vapor pressure 2 to 4×10^{-2} Torr/130° C [12]
$UO_2(C_6H_9O_2)_2$	m. p. 206 to 208° C (A) [12], 218 to 219° C (A) [13]
$CH_3COCH(CH_3)COCH_3 = C_6H_{10}O_2$, 3-methylpentane-2,4-dione	
	adduct with pyridine, $UO_2L_2(py)$, see vol. E1, p. 30
$CH_3COCH_2CO(n\text{-}C_3H_7) = C_7H_{12}O_2$, heptane-2,4-dione	
$U(C_7H_{11}O_2)_4$	liquid, b. p. 158° C/10^{-3} Torr (A) [13]
$UO_2(C_7H_{11}O_2)_2$	m. p. 85 to 86° C (A) [13]
$C_2H_5COCH_2COC_2H_5 = C_7H_{12}O_2$, heptane-3,5-dione	
$U(C_7H_{11}O_2)_4$	m. p. 63° C (A) [13], 64 to 65° C (A) [12]; subl. 145° C/2 $\times 10^{-4}$ Torr [13]; vapor pressure 7.7×10^{-3} Torr/130° C [12]

Table 1/60 (continued)

$CH_3COCH_2CO(i\text{-}C_3H_7)$ = $C_7H_{12}O_2$, 5-methylhexane-2,4-dione
- $U(C_7H_{11}O_2)_4$ liquid (A) [12, 13]; b. p. 155° C/10^{-3} Torr [13]
- $UO_2(C_7H_{11}O_2)_2$ m. p. 112 to 115° C (A) [12]

$CH_3COCH_2COC(:CH_2)CH_3$ = $C_7H_{10}O_2$, 5-methylhex-5-ene-2,4-dione
- $[UO_2(C_7H_9O_2)_2]_x$ (A) [74, 77]

$CH_3COCH_2COCH_2OC_2H_5$ = $C_7H_{12}O_3$, 5-ethoxypentane-2,4-dione
- $U(C_7H_{11}O_3)_4$ m. p. 80° C (A) [13]

$CH_3COCH_2CO(n\text{-}C_4H_9)$ = $C_8H_{14}O_2$, octane-2,4-dione
- $U(C_8H_{13}O_2)_4$ liquid, b. p. 175° C/10^{-3} Torr (A) [13]

$CH_3COCH_2CO(t\text{-}C_4H_9)$ = $C_8H_{14}O_2$, 5,5-dimethylhexane-2,4-dione
- $U(C_8H_{13}O_2)_4$ liquid, b. p. 142° C/2×10^{-3} Torr (A) [13]; subl. 130° C/1.9 $\times10^{-2}$ Torr (A) [12]; d. when heated [12]
- $UO_2(C_8H_{13}O_2)_2$ m. p. 150 to 152° C (A) [12]; also [77]

$CH_3COCH_2CO(n\text{-}C_5H_{11})$ = $C_9H_{16}O_2$, nonane-2,4-dione
- $U(C_9H_{15}O_2)_4$ liquid, b. p. 180° C/10^{-4} Torr (A) [13]
- $UO_2(C_9H_{15}O_2)_2$ m. p. 95 to 96° C (A) [13]

$(n\text{-}C_3H_7)COCH_2CO(n\text{-}C_3H_7)$ = $C_9H_{16}O_2$, nonane-4,6-dione
- $U(C_9H_{15}O_2)_4$ m. p. 21° C, b. p. 170° C/3×10^{-4} Torr (A) [13]
- $UO_2(C_9H_{15}O_2)_2$ m. p. 71 to 72° C (A) [13]

$(i\text{-}C_3H_7)COCH_2CO(i\text{-}C_3H_7)$ = $C_9H_{16}O_2$, 2,6-dimethylheptane-3,5-dione
- $U(C_9H_{15}O_2)_4$ solution ^{1}H-NMR data reported in [23]

$CH_3COCH_2CO(n\text{-}C_6H_{13})$ = $C_{10}H_{18}O_2$, decane-2,4-dione
- $U(C_{10}H_{17}O_2)_4$ liquid (A) [13]
- $UO_2(C_{10}H_{17}O_2)_2$ m. p. 76 to 78° C (A) [13]

$(t\text{-}C_4H_9)COCH_2CO(t\text{-}C_4H_9)$ = $C_{11}H_{20}O_2$, 2,2,6,6-tetramethylheptane-3,5-dione
- $U(C_{11}H_{19}O_2)_4$ brown (A) [27], greenish-brown (F) [37], green [47]; m. p. 208° C; vapor pressure, ln p(Torr) = $-(17932 \pm 184)/T + 35.625 \pm 0.315$ (range 119 to 136° C); ΔH(subl.) = 148.8 $\pm$ 1.3 kJ/mol; ΔS(subl.) = 250 $\pm$ 2.5 J · mol^{-1} · K^{-1} [27] vapor pressure, ln p(Torr) = $-(18309 \pm 400)/T + 42.36 \pm 0.6$ (for 372 to 478 K); ΔH(subl.) (425 K) = 152.2 $\pm$ 3.3 kJ/mol; ΔS(subl.) (425 K) = 256 $\pm$ 5 J · mol^{-1} · K^{-1} [141]
- $U(C_{11}H_{19}O_2)_2(C_{16}H_{14}N_2O_2)$ brown (F) [150]

  $C_{16}H_{16}N_2O_2$ = $(2\text{-}OH)C_6H_4CH:N(CH_2)_2N:CHC_6H_4(2\text{-}OH)$
- $UO_2(C_{11}H_{19}O_2)_2 \cdot H_2O$ $\nu_{as,OUO}$, 908 cm^{-1} [108]

$HOOC(CH_2)_4COCH_2CO(CH_2)_4COOH$ = $C_{13}H_{20}O_6$, 6,8-dioxotridecanedioic acid
- $UO_2(C_{13}H_{19}O_6)_x$ x unstated, yellow (E) [113]

$CH_3COCH_2CO(n\text{-}C_{17}H_{35})$ = $C_{21}H_{40}O_2$, stearoylacetone, heneicosane-2,4-dione
- $UO_2(C_{21}H_{39}O_2)_2$ yellow, m. p. 94.5° C (A, B) [122]

Literature to 1.2 see p. 24/7

Table 1/60 (continued)

$F_3COCH_2COCH_3 = C_5H_5F_3O_2$, 1,1,1-trifluoropentane-2,4-dione	
$U(C_5H_4F_3O_2)_4$	yellowish-brown (E) [33], khaki (F) [10]; m. p. 138 to 140° C (A) [12], 146° C (A) [13]; subl. 100 to 110° C/10^{-4} Torr [10]; vapor pressure 8×10^{-2} Torr/130° C [12]; $\nu_{U-O(C)}$, 219 cm^{-1} *) [33]
$UO_2(C_5H_4F_3O_2)_2$	yellow (A) [73], orange (A) [10]; m. p. 199 to 200° C (A) [12]; vapor pressure 2.7×10^{-3} Torr/130° C [12]; d. 160° C/10^{-4} Torr [10]; $\nu_{as,OUO}$, 928 (955?) cm^{-1}, $\nu_{s,OUO}$, 860(?) cm^{-1} [73]
$UO_2(C_5H_4F_3O_2)_2 \cdot H_2O$	m. p. 210° C (d) (B) [103]; $\nu_{as,OUO}$, 929 cm^{-1} (E) [108]
$CF_3COCH_2COCF_3 = C_5H_2F_6O_2$, 1,1,1,5,5,5-hexafluoropentane-2,4-dione	
$U(C_5HF_6O_2)_4$	brown (F) [10], (G) [33]; m. p. 60° C (A) [13], 90° C [10]; subl. 40 to 45° C/10^{-3} Torr [10]; b. p. 70° C/10^{-3} Torr [13], 145° C (d.) [10]; also (G) [29]
$UO_2(C_5HF_6O_2)_2 \cdot H_2O$	yellow, $\nu_{as,OUO}$, 925 (945?) cm^{-1} (A, in ether) [73]
$CF_3COCH_2COC_2H_5 = C_6H_7F_3O_2$, 1,1,1-trifluorohexane-2,4-dione	
$U(C_6H_6F_3O_2)_4$	m. p. 60° C (A) [13], 61° C (A) [12]; b. p. 116° C/10^{-3} Torr [13]; vapor pressure 2×10^{-2} Torr/130° C [12]
$CF_3COCH_2CO(n\text{-}C_3H_7) = C_7H_9F_3O_2$, 1,1,1-trifluoroheptane-2,4-dione	
$U(C_7H_8F_3O_2)_4$	m. p. 15° C, b. p. 132° C/10^{-3} Torr (A) [13]
$CF_3COCH_2CO(i\text{-}C_3H_7) = C_7H_9F_3O_2$, 1,1,1-trifluoro-5-methylhexane-2,4-dione	
$U(C_7H_8F_3O_2)_4$	m. p. 78° C, b. p. 134° C/3×10^{-3} Torr (A) [13]
$CF_3COCH_2CO(n\text{-}C_4H_9) = C_8H_{11}F_3O_2$, 1,1,1-trifluorooctane-2,4-dione	
$U(C_8H_{10}F_3O_2)_4$	liquid, b. p. 142° C/5×10^{-3} Torr (A) [13]
$CF_3COCH_2CO(t\text{-}C_4H_9) = C_8H_{11}F_3O_2$, 1,1,1-trifluoro-5,5-dimethylhexane-2,4-dione	
$U(C_8H_{10}F_3O_2)_4$	m. p. 136° C (A) [13], 138° C (A) [12]; b. p. 145° C/2×10^{-4} Torr [13]; vapor pressure 6.8×10^{-2} Torr/130° C [12]
$UO_2(C_8H_{10}F_3O_2)_2$	m. p. 134 to 136° C (A) [12]
$CF_3COCH_2COCH_2CH(CH_3)_2 = C_8H_{11}F_3O_2$, 1,1,1-trifluoro-6,6-dimethylhexane-2,4-dione	
$U(C_8H_{10}F_3O_2)_4$	m. p. 82° C, b. p. 141° C/2×10^{-3} Torr (A) [13]
$CF_3COCH_2CO(n\text{-}C_5H_{11}) = C_9H_{13}F_3O_2$, 1,1,1-trifluorononane-2,4-dione	
$U(C_9H_{12}F_3O_2)_4$	liquid, b. p. 166° C/4×10^{-3} Torr (A) [13]
$(n\text{-}C_3F_7)COCH_2CO(t\text{-}C_4H_9) = C_{10}H_{11}F_7O_2$, 1,1,1,2,2,3,3-heptafluoro-7,7-dimethyloctane-4,6-dione	
$U(C_{10}H_{10}F_7O_2)_4$	dark brown (E, ethanol under reflux) [26], olive brown (E) [22], greenish brown (A) [27]; m. p. 103 ± 1° C [26], 147° C [27], 148 to 150° C [22]; vapor pressure, ln p(Torr) = −(17238 ± 173)/T + 39.875 ± 0.484 (range 70 to 94° C); ΔH(subl.) = 143.4 ± 1.3 kJ/mol; ΔS(subl.) = 277 ± 4 J · mol^{-1} · K^{-1} [27]; vapor pressure, ≈2×10^{-3} Torr (310 K), ≈1.5 Tor (405 K); ΔH (subl.) = 68.1 kJ/mol (from vapor pressure data), ΔH (subl.) = 64.209 ± 3.177 kJ/mol (calorimetric) [144]
$UO_2(C_{10}H_{10}F_7O_2)_2$	(?) orange, unstable [26]

Table 1/60 (continued)

$CH_3COCHClCOCH_3$ = $C_5H_7ClO_2$, 3-chloropentane-2,4-dione

$U(C_5H_6ClO_2)_4$	(A) [8]
$UO_2(C_5H_6ClO_2)_2$	golden-orange (A) [8]

$C_6H_5COCH_2COC_6H_5$ = $C_{15}H_{12}O_2$, 1,3-diphenylpropane-1,3-dione, dibenzoylmethane

$U(C_{15}H_{11}O_2)_4$	red-brown (A, at 65° C) [2], (F) [37, 47]; reddish-brown (E) [33]; black-violet (D, in C_6H_6 under reflux) [11]; brown-violet (B) [5]; dark brown [22]; m. p. 168° C [13]; 180° C (d.) [20], 185 to 186° C [5], 192 to 193° C [11], 198 to 199° C (but d. >180° C) [12], 200 to 202° C [22]; subl. under high vacuum [11]; $\nu_{U-O(C)}$, 207 cm^{-1} *) [33]
$U(C_{15}H_{11}O_2)_2(C_{16}H_{14}N_2O_2)$	deep brown (F) [150]

$C_{16}H_{16}N_2O_2$ = $(2\text{-}OH)C_6H_4CH{:}N(CH_2)_2N{:}CHC_6H_4(2\text{-}OH)$

$U(OC_2H_5)_4(C_{15}H_{11}O_2)$	dark brown, viscous liquid, b. p. 125 to 127° C/0.2 Torr (H) [49]
$U(OC_2H_5)_3(C_{15}H_{11}O_2)_2$	brown paste, d. 130 to 131° C/0.5 Torr (H) [49]
$U(OC_2H_5)_2(C_{15}H_{11}O_2)_3$	brown, d. 129 to 130° C/0.5 Torr (H) [49]
$U(O\text{-}t\text{-}C_4H_9)_4(C_{15}H_{11}O_2)$	red-brown paste, d. 131 to 133° C/0.5 Torr (J) [49]
$U(O\text{-}t\text{-}C_4H_9)_3(C_{15}H_{11}O_2)_2$	red-brown, d. 125 to 128° C/0.5 Torr (J) [49]
$U(O\text{-}t\text{-}C_4H_9)_2(C_{15}H_{11}O_2)_3$	orange-brown, d. 122 to 126° C/0.5 Torr (J) [49]
$UO_2(C_{15}H_{11}O_2)_2$	orange (oxidation of $U(C_{15}H_{11}O_2)_4$) [11], red-orange [53]; d. 245° C [53]; $\nu_{as,OUO}$, 920 cm^{-1} [65, 66], 904 cm^{-1} [108]; $\nu_{s,OUO}$, 886 cm^{-1} [65, 66]
$UO_2(C_{15}H_{11}O_2)_2 \cdot H_2O$	$\nu_{as,OUO}$, 915 cm^{-1} [108]
$UO_2(C_{15}H_{11}O_2)_2 \cdot 2\ H_2O$	[71, 83]
$UO_2(C_{15}H_{11}O_2)_2 \cdot 2.5\ H_2O$	orange (red above 140° C), m. p. 267 to 271° C (d) (C) [59]; $\nu_{as,OUO}$, 900 to 913 cm^{-1} [65, 66]; also [63]

$C_6H_5COCH_2CSC_6H_5$ = $C_{15}H_{12}OS$, 1,3-diphenyl-3-thioxopropan-1-one

$UO_2(C_{15}H_{11}OS)_2$	red, m. p. 180 to 181° C (E) [96]
$UO_2(C_{15}H_{11}OS)_2 \cdot H_2O$	dark red, m. p. 100° C (d.), $\nu_{as,OUO}$, 922 cm^{-1} (F) [126]

$C_6H_5COCH_2CO(C_6H_4NH_2)$ = $C_{15}H_{13}NO_2$, 1-(aminophenyl)-3-phenylpropane-1,3-dione

$UO_2(C_{15}H_{12}NO_2)_2$	[63] (*m*-aminophenyl compound)
$UO_2(C_{15}H_{12}NO_2)_2$	[63] (*p*-aminophenyl compound)

$C_6H_5COCH_2CO(C_6H_4NO_2)$ = $C_{15}H_{11}NO_4$, 1-(nitrophenyl)-3-phenylpropane-1,3-dione

$UO_2(C_{15}H_{10}NO_4)_2$	[63] (*o*-nitrophenyl compound)
$UO_2(C_{15}H_{10}NO_4)_2 \cdot 1.5\ H_2O$	[63] (*m*-nitrophenyl compound)
$UO_2(C_{15}H_{10}NO_4)_2 \cdot 1.5\ H_2O$	[63] (*p*-nitrophenyl compound)

$C_6H_5COCH_2CO(C_6H_4OCH_3)$ = $C_{16}H_{14}O_3$ = 1-(methoxyphenyl)-3-phenylpropane-1,3-dione

$UO_2(C_{16}H_{13}O_3)_2$	[63] (*o*-methoxyphenyl compound)
$UO_2(C_{16}H_{13}O_3)_2$	[63] (*m*-methoxyphenyl compound)
$UO_2(C_{16}H_{13}O_3)_2$	[63] (*p*-methoxyphenyl compound)

Literature to 1.2 see p. 24/7

Table 1/60 (continued)

$CH_3COCH_2COC_6H_5$ = $C_{10}H_{10}O_2$, 1-phenylbutane-1,3-dione, benzoylacetone	
$U(C_{10}H_9O_2)_4$	red-brown (B) [5], (A, at 65° C) [2], reddish-brown (E) [33]; m. p. 190 to 195° C (A) [12], 197 to 198° C [5], 206° C (d.) [13], 210° C (d.) [2]; $\nu_{U-O(C)}$, 213 cm^{-1} *) [33]
$U(OC_2H_5)_4(C_{10}H_9O_2)$	brown, viscous liquid, b. p. 110 to 112° C/0.4 Torr (H) [48]
$U(OC_2H_5)_3(C_{10}H_9O_2)_2$	dark brown, viscous liquid (H) [48]
$U(OC_2H_5)_2(C_{10}H_9O_2)_3$	brown, pasty solid (H) [48]
$U(O\text{-}t\text{-}C_4H_9)_4(C_{10}H_9O_2)$	brown, subl. 210 to 220° C/0.4 Torr (J) [48]
$U(O\text{-}t\text{-}C_4H_9)_2(C_{10}H_9O_2)_3$	brown, subl. 215 to 230° C/0.9 Torr (J) [48]
$UO_2(C_{10}H_9O_2)_2$	m. p. 157 to 158° C (A) [12]; $\nu_{as,OUO}$, 915 cm^{-1} [65, 66], 918 cm^{-1} [108]; $\nu_{s,OUO}$, 887 cm^{-1} [65, 66]
$UO_2(C_{10}H_9O_2)_2 \cdot H_2O$	$\nu_{as,OUO}$, 919 cm^{-1} (E) [108]
$UO_2(C_{10}H_9O_2)_2 \cdot 2.5\ H_2O$	orange (red above 112° C) (C) [59]; m. p. 258 to 259° C [59]; $\nu_{as,OUO}$, 910 cm^{-1} [63, 65, 66]; also 3 H_2O [83]
$C_6H_5COCH_2COCOOH$ = $C_{10}H_8O_4$, 2,4-dioxo-4-phenylbutanoic acid	
$UO_2(C_{10}H_7O_4)$	yellow, d. 280° C (E) [56]; COOH group evidently involved in bonding to the U atom
$C_6H_5COCH_2COCOOCH_3$ = $C_{11}H_{10}O_4$, 2,4-dioxo-4-phenylbutanoic acid methyl ester	
$UO_2(C_{11}H_9O_4)_2 \cdot H_2O$	orange (?), m. p. 155 to 156° C (d) [56]
$C_6H_5COCH_2COCOOC_2H_5$ = $C_{12}H_{12}O_4$, 2,4-dioxo-4-phenylbutanoic acid ethyl ester	
$UO_2(C_{12}H_{11}O_4)_2 \cdot x\ H_2O$	x = 0, orange; x = 2, yellow [56]
$CH_3COCH_2COC_6H_4(o\text{-}OCH_3)$ = $C_{11}H_{12}O_3$, 1-(*o*-methoxyphenyl)butane-1,3-dione	
	adduct with ethanol, $UO_2L_2 \cdot 0.5\ C_2H_5OH$, see vol. E1, p. 60
$CF_3COCH_2COC_6H_5$ = $C_{10}H_7F_3O_2$, 4,4,4-trifluoro-1-phenylbutane-1,3-dione	
$U(C_{10}H_6F_3O_2)_4$	reddish-brown (E) [33]; (G) [42]; subl. 200° C/10^{-2} Torr (G) [34]; b. p. 191° C/3×10^{-3} Torr (A) [13]; $\nu_{U-O(C)}$, 210 cm^{-1} *) [33]
$UO_2(C_{10}H_6F_3O_2)_2$	yellow, m. p. 156° C (E) [91]
$CH_3COCH_2COC_6H_4(p\text{-}NHCH_2COOH)$ = $C_{12}H_{13}NO_4$, N-(*p*-acetoacetylphenyl)glycine, 1-(*p*-carboxymethylaminophenyl)butane-1,3-dione	
$(UO_2(C_{12}H_{11}NO_4))_x$	red, d. 330 to 350° C (E) [76] (carboxylate groups probably involved in bonding to the U atom)
$C_6H_5COCH_2COC_2H_5$ = $C_{11}H_{12}O_2$, 1-phenylpentane-1,3-dione	
$U(C_{11}H_{11}O_2)_4$	(A) [140]
3,5-$(CH_3)_2C_6H_3COCH_2COC_6H_3$-3,5-$(CH_3)_2$ = $C_{19}H_{20}O_2$, 1,3-di(3,5-dimethylphenyl)-propane-1,3-dione	
$UO_2(C_{19}H_{19}O_2)_2$	yellow, m. p. 145 to 147° C (E) [88]
$C_6H_5COCH_2CO(n\text{-}C_3H_7)$ = $C_{12}H_{14}O_2$, 1-phenylhexane-1,3-dione	
$U(C_{12}H_{13}O_2)_4$	brown, m. p. 106 to 108° C (B) [22]
$C_6H_5COCH_2CO(i\text{-}C_3H_7)$ = $C_{12}H_{14}O_2$, 4-methyl-1-phenylpentane-1,3-dione	
$U(C_{12}H_{13}O_2)_4$	(A) [140]