

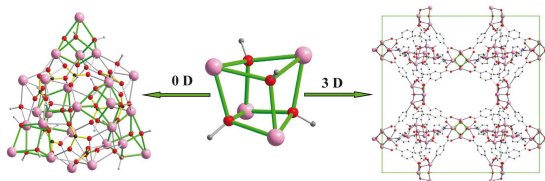


Zeeshan Majeed (Autor)

Employing Crystal Engineering Principles to Fabricate Zero to Three-Dimensional 4f-based Metal Aggregates using O-Donor Ligands

Zeeshan Majeed

Employing Crystal Engineering Principles
to Fabricate Zero to Three-Dimensional
4f-based Metal Aggregates
using O-Donor Ligands



Cuvillier Verlag Göttingen
Internationaler wissenschaftlicher Fachverlag

<https://cuvillier.de/de/shop/publications/6320>

Copyright:

Cuvillier Verlag, Inhaberin Annette Jentsch-Cuvillier, Nonnenstieg 8, 37075 Göttingen,
Germany

Telefon: +49 (0)551 54724-0, E-Mail: info@cuvillier.de, Website: <https://cuvillier.de>



Contents

Chapter 1: Introduction	1
1.1 Crystal engineering: <i>A vital tool in modern coordination chemistry</i>	2
1.2 Introduction to magnetochemistry	3
1.2.1 Magnetic susceptibility	3
1.2.2 Types of magnetic states	3
1.2.3 Determination of magnetic behavior: Curie and Curie-Weiss laws	5
1.2.4 Molecule-based magnets (MBMs)	6
1.2.4.1 Single molecule magnets (SMMs)	6
1.2.4.2 Single chain magnets (SCMs)	7
1.3 Introduction to lanthanide (Ln) chemistry	9
1.4 Introduction to Ln–Mn chemistry	14
1.5 Introduction to Ln–POM chemistry	16
1.6 Synthetic strategy	19
1.7 Ligand selection strategy	21
1.4 Thesis overview	25
Chapter 2: Research objectives	26
Chapter 3: Structures and magnetic properties of Ln–carboxylate coordination polymers (1 - 27)	28
3.1 The 2D coordination polymer $[\text{LnNa}(\text{CH}_3\text{CO}_2)_4(\text{MeOH})]_n$ {Ln = Dy(1)}	28
3.1.1 Structure description	29
3.1.2 Magnetic properties	31
3.2 The 3D coordination polymers $[\text{LnNa}(\text{C}_3\text{H}_7\text{CO}_2)_4]_n$ {Ln = Gd(2), Tb(3), Dy(4), Ho(5), Er(6)}	32
3.2.1 Structure description	32
3.2.2 Magnetic properties	34
3.3 The 1D coordination polymers $[\text{Ln}_2(\text{C}_6\text{H}_5\text{CO}_2)_6(\text{MeOH})_4]_n$ {Ln = Gd(7), Tb(8), Dy(9), Ho(10)}	38
3.3.1 Structure description	38
3.3.2 Magnetic properties	40
3.4 The 3D coordination polymers $[\text{LnNa}(\text{C}_6\text{H}_5\text{CO}_2)_4]_n$ {Ln = Y(11), Tb(12), Dy(13), Ho(14), Er(15)}	43



Contents

3.4.1 Structure description	43
3.4.2 Magnetic properties	46
3.5 The 1D coordination polymers $[\text{Ln}_2(\text{ClC}_6\text{H}_4\text{CO}_2)_6(\text{EtOH})_4]_n$ {Ln = Gd(16), Tb(17), Dy(18), Ho(19), Er(20)}	48
3.5.1 Structure description	49
3.5.2 Magnetic properties	51
3.6 The 3D coordination polymers $[\text{Ln}_4(\text{OH})_4(\text{IN})_6(\text{NO}_3)(\text{H}_2\text{O})_4]_n(\text{IN})_x(\text{NO}_3)_{1-x}$ {Ln = Y(21), Eu(22), Gd(23), Tb(24), Dy(25), Ho(26), Er(27)}	56
3.6.1 Structure description	57
3.6.2 Magnetic properties	60
3.7 Summary	65
Chapter 4: Structures and magnetic properties of Ln–polyol–carboxylate coordination compounds (28 – 62)	67
4.1 The linear trilanthanide clusters $[\text{Ln}_3\text{Na}(\text{C}_3\text{H}_7\text{O}_3)_2(\text{C}_4\text{H}_9\text{CO}_2)_8(\text{C}_4\text{H}_9\text{CO}_2\text{H})(\text{H}_2\text{O})]$ {Ln = Gd(28), Tb(29), Dy(30), Ho(31), Er(32)}	67
4.1.1 Structure description	68
4.1.2 Magnetic properties	70
4.2 The 1D coordination polymers $[\text{Ln}_6(\text{C}_3\text{H}_7\text{O}_3)_3(\text{C}_2\text{H}_5\text{CO}_2)_{15}]_n$ {Ln = Tb(33), Dy(34), Ho(35)}	77
4.2.1 Structure description	77
4.2.2 Magnetic properties	80
4.3 The 1D coordination polymers $[\text{Ln}_6(\text{C}_3\text{H}_7\text{O}_3)_3(\text{ClC}_2\text{H}_4\text{CO}_2)_{15}]_n$ {Ln = Tb(36), Dy(37), Ho(38), Er(39)}	86
4.3.1 Structure description	86
4.3.2 Magnetic properties	89
4.4 The 1D coordination polymers $[\text{Ln}_2(\text{C}_3\text{H}_8\text{O}_3)_2(\text{C}_6\text{H}_5\text{CO}_2)_6]_n$ {Ln = Y(40), Eu(41), Gd(42), Tb(43), Dy(44), Ho(45), Er(46)}	96
4.4.1 Structure description	96
4.4.2 Magnetic properties	99
4.5 The 2D coordination polymers $[\text{Ln}_3(\text{OH})(\text{C}_3\text{H}_7\text{O}_3)_3(\text{O}_2\text{CC}_6\text{H}_4\text{CO}_2)_{3/2}(\text{H}_2\text{O})_3]_n \cdot \text{Cl}_2$ {Ln = Tb(47), Dy(48), Ho(49), Er(50)}	105
4.5.1 Structure description	106
4.5.2 Magnetic properties	108



Contents

4.6 The tetra-nuclear clusters $[\text{Ln}_4(\text{OH})_2(\text{C}_4\text{H}_9\text{O}_3)_2(\text{C}_6\text{H}_5\text{CO}_2)_6(\text{NO}_3)_2]$ {Ln = Dy(51), Ho(52), Er(53)}	112
4.6.1 Structure description	112
4.6.2 Magnetic properties	114
4.7 The high nuclearity Ln_{26} -benzoate clusters {Ln = Y(54), Dy(55)} {Tb(56), Dy(57), Ho(58)}	118
4.7.1 Structure description	118
4.7.2 Magnetic properties	123
4.8 The high nuclearity Ln_{26} -pivalate clusters {Ln = Tb(59), Dy(60), Ho(61), Er(62)}	127
4.8.1 Structure description	127
4.8.2 Magnetic properties	128
4.9 Summary	130
Chapter 5: Structures and magnetic properties of Ln–Mn and Ln–POM coordination clusters (63 – 75)	133
5.1 The decanuclear clusters $[\text{Ln}_6\text{Mn}_4(\text{OH})_2(\text{C}_3\text{H}_6\text{O}_3)_4(\text{C}_3\text{H}_7\text{O}_3)_2(\text{C}_6\text{H}_5\text{CO}_2)_{16}(\text{X})_2]$ {Ln = Gd(63), Tb(64), Dy(65), Ho(66), Y(67), Er(68), Tm(69)}	134
5.1.1 Structure description	134
5.1.2 Magnetic properties	137
5.2 The organic/inorganic hybrid Ln–POM clusters $\text{Na}_8 \{ \text{Ln}(\text{H}_2\text{NC}_2\text{H}_4\text{CO}_2)_2(\text{H}_2\text{O})_5 \} [\text{W}_{22}\text{O}_{70}(\text{AsO}_3)_2\text{Ln}_4\text{Na}(\text{H}_2\text{NC}_2\text{H}_4\text{CO}_2)_5(\text{CH}_3\text{CO}_2)_2(\text{H}_2\text{O})_{13}] \text{Cl} \cdot x\text{H}_2\text{O}$ {Ln = Tb(70), Dy(71), Ho(72), Er(73), Tm(74), Yb(75), }	146
5.2.1 Structure description	146
5.2.2 Magnetic properties	148
5.3 Summary	155
Chapter 6: Conclusions	157
Chapter 7: Zusammenfassung	161
Chapter 8: Experimental	163
Chapter 9: Crystallographic data	175
Chapter 10: Bibliography	194
Appendix I: List of abbreviations	202
Appendix II: List of compounds	204



Contents

Appendix III: List of schemes	205
Appendix IV: List of tables	206
Curriculum Vitae	207