Supplementary Information

Bismuth(III) Complexes Derived from *α*-Amino Acids: The Impact of Hydrolysis and Oxido-Cluster Formation on their Activity against *Helicobacter pylori*

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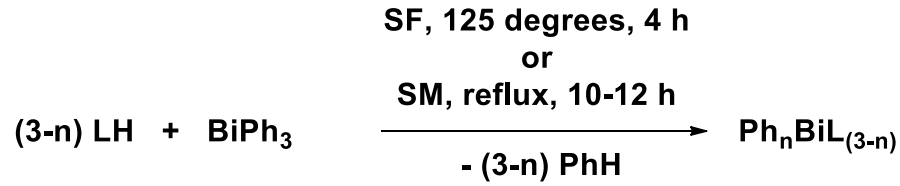
Contents

An example of the DSC analysis of the SF reaction of $BiPh_3$ and L-proline in the ratio of 1:3 (Scheme S1) is shown in Figure S1.



Scheme S1. Proposed reaction scheme for the synthesis of Bi(III) *α*-amino acid derived complexes using the SF- and SM-methods.

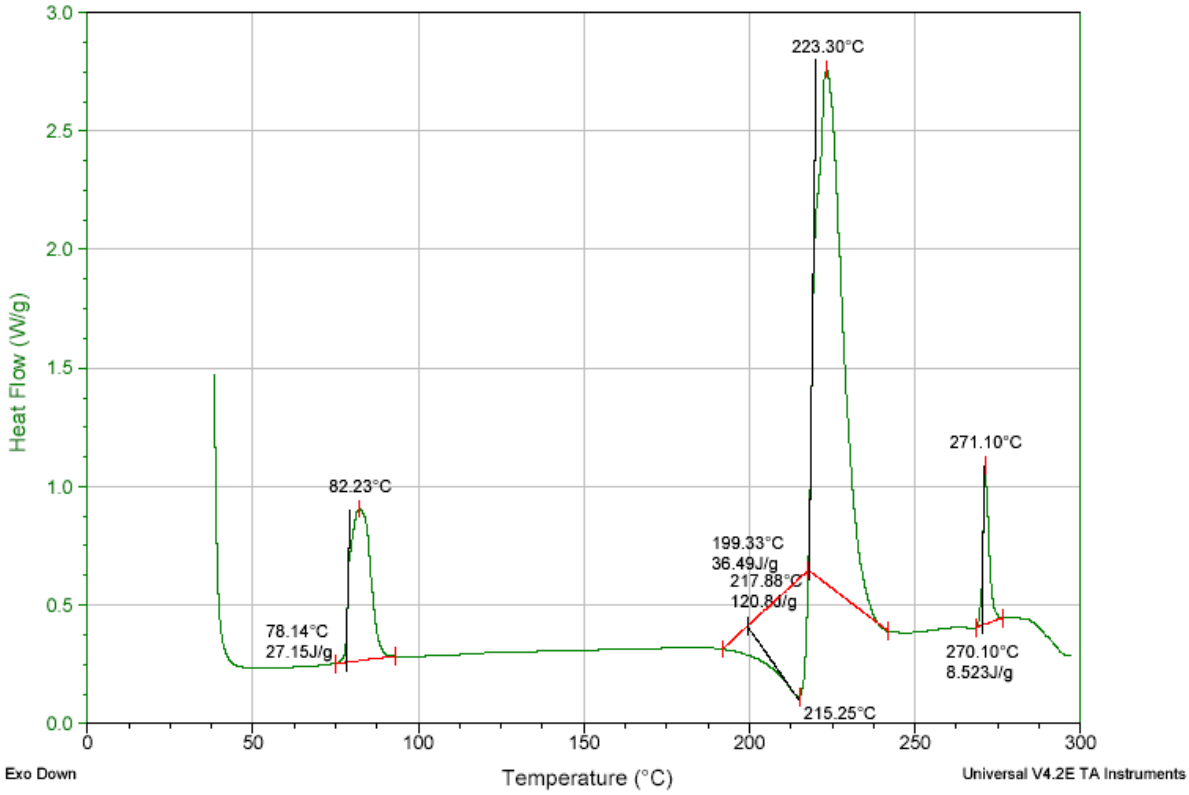


Figure S1. DSC plot of the SF reaction of $BiPh_3$ and *L*-proline in the ratio of 1:3.

Table S1 shows some proposed ions, which would be expected in the positive ESI-MS of compound **8**. Although four peaks are observed in the original spectrum (labelled in **bold** in Table S1), they do not explain the full ESI-MS spectrum of **8**. However, it is possible that more than one single species is present in the aqueous solution. Unfortunately, due to limited instrumentation access the positive ESI-MS were only detected to *m/z* = 1000, and therefore, it cannot be determined whether the fragmentation ions belong to one single or more species. More suitable techniques such as matrix assisted laser desorption ionisation (MALDI), inductively coupled plasma mass spectrometry (ICP-MS) or liquid-chromatography mass spectrometry (LC-MS) are required to provide an answer to this question.

Table S1. Proposed ions for a positive mass spectrum (solvent: MeOH/H_2O = 5/1) for compound **8**. The *m/z* labelled in **bold** are observed in the original spectrum, but they do not explain the full spectrum.

assignment	[m/z]				
	M = H	**M = Na**	**M = K**	**R = OMe**	**R* = OH**
$[Bi_2L_3+M]^+$	**854.3**	876.3	892.4		
$[Bi_2L_3+M\ (MeOH)]^+$	886.3	908.3	**924.4**		
$[Bi_2L_3+M\ (H_2O)]^+$	872.3	894.3	910.4		
$[Bi_2L_2(R \text{ or } R^*)]^+$				739.2	725.2
$[Bi_2L_2(R \text{ or } R^*)\ (MeOH)]^+$				771.3	757.2
$[Bi_2L_2(R \text{ or } R^*)\ (H_2O)]^+$				757.2	**743.2**
$[Bi_2L(R \text{ or } R^*)_2]^{2+}$				312.6	298.5
$[Bi_2L(R \text{ or } R^*)_2$				328.6	314.6
$[Bi_2L(R \text{ or } R^*)_2\ (H_2O)]^{2+}$				321.6	307.5
$[Bi_2LRR^*]^{2+}$				305.6	
$[Bi_2LRR^*\ (MeOH)]^{2+}$				321.6	
$[Bi_2LRR^*\ (H_2O)]^{2+}$				314.6	
$[Bi_2L(R \text{ or } R^*)_3]^+$				656.1	614.1
$[Bi_2L(R \text{ or } R^*)_3\ (MeOH)]^+$				688.2	646.1
$[Bi_2L(R \text{ or } R^*)_3\ (H_2O)]^+$				674.2	631.1
$[Bi_2LR_2R^*]^+$				642.1	
$[Bi_2LR_2R^*\ (MeOH)]^+$				674.2	
$[Bi_2LR_2R^*\ (H_2O)]^+$				659.1	
$[Bi_2LRR^*_2]^+$				628.1	
$[Bi_2LRR^*_2\ (MeOH)]^+$				660.1	
$[Bi_2LRR^*_2\ (H_2O)]^+$				645.1	
$[BiL(OMe)+M]^+$	386.1	408.1	424.2		
$[BiL(OMe)+M\ (MeOH)]^+$	418.2	440.2	456.3		
$[BiL(OMe)+M\ (H_2O)]^+$	404.1	426.1	**442.2**		
$[BiL(OH)+M]^+$	371.1	394.1	410.2		
$[BiL(OH)+M\ (MeOH)]^+$	404.1	426.1	442.2		
$[BiL(OH)+M\ (H_2O)]^+$	390.1	412.1	428.2		
$[BiL]^+$					354.1
$[BiL\ (MeOH)]^+$					386.1
$[BiL\ (H_2O)]^+$					371.1

Table S2. Assignment of fragmentation peaks obtained from the positive ESI-MS of compound **8**.

m/z	m found	abundance	assignment	*m/z*	m
982.1	3928.4	15	$[Bi_{14}O_{10}L_2(OH)_{14}(MeOH)_7(H_2O)_5]^{4+}$	3928.4	982.1
894.3	3577.2	15	$[Bi_{12}O_{10}L_3(OH)_6(MeOH)_6(H_2O)_{10}]^{4+}$	3577.5	894.4
883.4	3533.6	30	$[Bi_{10}O_8L_4(OH)_2(MeOH)_{14}(H_2O)_{14}]^{4+}$	3533.0	883.3
854.1	3416.4	10	$[Bi_{12}O_{10}L_4(OH)_4(MeOH)_2(H_2O)_2]^{4+}$	3416.3	854.1
824.1	3296.4	20	$[Bi_{10}O_8L_4(OH)_2(MeOH)_{10}(H_2O)_8]^{4+}$	3296.8	824.2
810.4	3241.6	25	$[Bi_{12}O_{10}L_4(OH)_4(H_2O)_2]^{4+}$	3241.1	810.3
786.9	3147.6	10	$[Bi_{10}O_8L_5(MeOH)_3(H_2O)_6]^{4+}$	3147.5	786.9
780.2	3120.8	20	$[Bi_{10}O_8L_4(OH)_2(MeOH)_9]^{4+}$	3120.6	780.1
765.0	3060.0	15	$[Bi_{10}O_8L_4(OH)_2(MeOH)_6(H_2O)_2]^{4+}$	3060.5	765.1
758.2	3032.8	30	$[Bi_{10}O_8L_4(OH)_2(MeOH)_4(H_2O)_4]^{4+}$	3032.5	758.1
747.3	2989.2	5	$[Bi_{10}O_8L_3(OH)_4(MeOH)_5(H_2O)_6]^{4+}$	2989.4	747.4
742.9	2971.6	10	$[Bi_{10}O_8L_3(OH)_4(MeOH)_5(H_2O)_5]^{4+}$	2971.4	742.9
736.3	2945.2	35	$[Bi_9O_7L_3(OH)_3(MeOH)_{14}(H_2O)]^{4+}$	2945.8	736.4
721.0	2884.0	5	$[Bi_9O_7L_4(OH)(MeOH)_3(H_2O)_{11}]^{4+}$	2884.5	721.1
708.2	2832.8	5	$[Bi_9O_7L_2(OH)_5(MeOH)_{10}(H_2O)_8]^{4+}$	2832.6	708.1
699.2	2796.8	10	$[Bi_9O_7L_2(OH)_5(MeOH)_{10}(H_2O)_6]^{4+}$	2796.6	699.1
695.7	2782.8	15	$[Bi_9O_7L_4(OH)(MeOH)_6]^{4+}$	2782.5	695.6
684.7	2738.8	5	$[Bi_9O_7L_3(OH)_3(MeOH)_7(H_2O)_2]^{4+}$	2739.5	684.9
677.1	2708.4	25	$[Bi_9O_7L_2(OH)_5(MeOH)_5(H_2O)_{10}]^{4+}$	2708.4	677.1
655.1	2620.4	30	$[Bi_9O_7L_2(OH)_5(H_2O)_{14}]^{4+}$	2620.3	655.1
633.3	2533.2	25	$[Bi_9O_7L_3(OH)_3(H_2O)_3]^{4+}$	2533.2	633.3
615.3	2461.2	10	$[Bi_8O_6L_3(OH)_2(MeOH)_7]^{4+}$	2461.5	615.4
611.2	2044.8	65	$[Bi_8O_6L_4(MeOH)_3]^{4+}$	2444.4	611.1
595.9	2383.6	15	$[Bi_8O_6L_3(OH)_2(MeOH)_4(H_2O)]^{4+}$	2383.4	595.8
589.2	2356.8	50	$[Bi_8O_6L_2(OH)_4(MeOH)(H_2O)_{11}]^{4+}$	2356.3	589.1
574.0	2296.0	45	$[Bi_8O_6L(OH)_6(MeOH)_2(H_2O)_{12}]^{4+}$	2295.2	573.8
568.1	2272.4	30	$[Bi_8O_6L_2(OH)_4(MeOH)_4(H_2O)]^{4+}$	2272.3	568.1

Table S2. Assignment of fragmentation peaks obtained from the positive ESI-MS of compound **8** – to be continued.

m/z	m found	abundance	assignment	*m/z*	m
552.0	2208.0	45	$[Bi_6O_4L_2(OH)_2(MeOH)_{16}(H_2O)_3]^{4+}$	2208.8	552.2
530.1	2120.4	65	$[Bi_6O_4L_2(OH)_2(MeOH)_{11}(H_2O)_7]^{4+}$	2120.7	530.2
518.0	2072.0	5	$[Bi_6O_4L_2(OH)_2(MeOH)_5(H_2O)_{15}]^{4+}$	2072.5	518.1
508.1	2032.4	85	$[Bi_6O_4L_2(OH)_2(MeOH)_6(H_2O)_{11}]^{4+}$	2032.5	508.1
502.1	2008.4	5	$[Bi_6O_4L_2(OH)_2(MeOH)_3(H_2O)_{15}]^{4+}$	2008.5	502.1
486.1	1944.4	100	$[Bi_6O_4L_2(OH)_2(MeOH)(H_2O)_{15}]^{4+}$	1944.4	486.1
480.0	1920.0	5	$[Bi_6O_4L_2(OH)_2(MeOH)_7(H_2O)_3]^{4+}$	1920.4	480.1
464.2	1856.8	65	$[Bi_6O_3L_2(OH)_3(MeOH)_5(H_2O)_3]^{4+}$	1857.4	464.3
442.2	1768.8	95	$[Bi_6O_3L_2(OH)_3(H_2O)_7]^{4+}$	1769.2	442.3
437.4	1749.6	15	$[Bi_6O_4L_2(OH)_2(H_2O)_6]^{4+}$	1750.2	437.5
405.0	1620.0	35	$[Bi_4O_2L_2(MeOH)_6(H_2O)_{15}]^{4+}$	1620.6	405.2
383.0	1532.0	90	$[Bi_4O_2L_2(MeOH)_{10}(H_2O)_3]^{4+}$	1532.6	383.1
361.0	1444.0	100	$[Bi_4O_2L_2(MeOH)_5(H_2O)_7]^{4+}$	1444.4	361.1
348.2	1392.8	90	$[Bi_4O_2L_2(H_2O)_{13}]^{4+}$	1392.3	348.1
339.1	1356.4	30	$[Bi_4O_2L_2(H_2O)_{11}]^{4+}$	1356.3	339.1
333.0	1332.0	25	$[Bi_3L_2(OH)(MeOH)_4(H_2O)_{15}]^{4+}$	1332.5	333.1
317.2	1268.8	50	$[Bi_4O_2L(OH)_2(MeOH)_3(H_2O)_7]^{4+}$	1269.3	317.3
295.2	1180.8	65	$[Bi_3OL(OH)(MeOH)_5(H_2O)_{12}]^{4+}$	1181.4	295.4
264.0	1056.0	5	$[Bi_3L_2(OH)(MeOH)(H_2O)_5]^{4+}$	1056.3	264.1
214.0	-	10	$[LNa_2+Na]^+$	214.1	-
204.3	-	5	$[LH_2(H_2O)+K]^+$	204.2	-
192.1	-	10	$[LHNa+Na]^+$	192.1	-
184.3	-	5	$[LH_2(H_2O)_2+H]^+$	184.1	-
170.2	-	5	$[LH_2+Na]^+$	170.0	-
148.2	-	50	$[LH_2+H]^+$	148.1	-

Table S3. Comparison of the elemental analysis results obtained for compounds **1** to **8** with the calculated (calcd.) values (in **bold** labelled values show good agreement between found and calcd. values).

	assignment (MW)	EA found [%]			EA calcd. [%]					
					$[BiL_3]$			$[Bi_2L_3]$		
		C	H	N	C	H	N	C	H	N
1	$[Bi(Phe)_3]\cdot H_2O$	**44.80**	**4.50**	**5.65**	**45.07**	**4.48**	**5.84**	-	-	-
2	$[Bi(Pro)_3]\cdot H_2O$ (569.352)	**31.52**	**4.79**	**7.28**	**31.64**	**4.60**	**7.38**	-	-	-
3	$[Bi(Met)_3]$ (653.583)	**27.44**	**4.49**	**6.70**	**27.56**	**4.63**	**6.43**	-	-	-
4	$[Bi_2(Cys)_3]$ (775.383)	**13.86**	**2.10**	**5.25**	19.08	2.67	7.42	**13.94**	**1.95**	**5.42**
5	$[Bi(Ser)_3]\cdot H_2O$ (539.241)	**19.91**	**3.83**	**7.68**	**20.04**	**3.74**	**7.79**	14.45	2.69	5.62
6	$[Bi(Tyr)_3]$ (749.502)	**43.35**	**4.00**	**5.42**	**43.26**	**4.03**	**5.61**	33.83	3.15	4.38
7	$[Bi_2(Asp)_3]$ (775.383)	**17.70**	**1.72**	**5.31**	23.93	2.51	6.98	**17.77**	**1.86**	**5.18**
8	$[Bi_2(Glu)_3]$ (853.287)	**21.02**	**2.46**	**5.03**	27.96	3.29	6.52	**21.11**	**2.48**	**4.92**

Table S4. Summary of the biological test results – MIC values [µM] relating to the molecular mass of the initial Bi(III) complex **1** to **8**.

Compound	Aqueous Solubility (mg/mL)		Activity [MIC µM]		
	pH 7	pH 2	251	B128	26695
Bismuth *Sub*salicylate	***insol***	<0.5	34.4	34.4	34.4
Colloidal Bismuth *Sub*citrate	179	<0.5	25.2	25.2	25.2
Ranitidine Bismuth Citrate	625	<0.5	25.4	25.4	25.4
$BiPh_3$	***insol***	***insol***	**>145.4**	**>145.4**	**>145.4**
LH	***sol***	***sol***		**non-toxic**	
$[Bi(Phe)_3]$ – **1** (tested in DMSO)	***insol***	***insol***	**17.4**	**0.068**	**4.343**
$[Bi(Pro)_3]$ – **2** (tested in DMSO)	***insol***	***insol***	**2.745**	**22.0**	**87.8**
$[Bi(Met)_3]$ – **3** (tested in DMSO)	***sol***	***sol***	**4.781**	**19.1**	**38.3**
$[Bi(Met)_3]$ – **3** (tested in water)	***sol***	***sol***	**9.56**	**38.3**	**38.3**
$[Bi_2(Cys)_3]$ – **4** (tested in DMSO)	***sol***	***sol***	**0.251**	**0.063**	**0.251**
$[Bi_2(Cys)_3]$ – **4** (tested in water)	***sol***	***sol***	**32.2**	**0.063**	**129.0**
$[Bi(Ser)_3]$ – **5** (tested in DMSO)	***sol***	***sol***	**0.182**	**0.091**	**92.7**
$[Bi(Ser)_3]$ – **5** (tested in water)	***sol***	***sol***	**185.4**	**185.4**	**92.7**
$[Bi(Tyr)_3]$ – **6** (tested in DMSO)	***sol***	***sol***	**4.169**	**8.34**	**33.4**
$[Bi_2(Asp)_3]$ – **7** (tested in DMSO)	***sol***	***sol***	**4.030**	**32.2**	**32.2**
$[Bi_2(Glu)_3]$ – **8** (tested in DMSO)	***sol***	***sol***	**14.6**	**0.057**	**0.229**
$[Bi_2(Glu)_3]$ – **8** (tested in water)	***sol***	***sol***	**29.3**	**14.6**	**0.915**