Salt metathesis versus protonolysis routes for the synthesis of silylamide Hauser base (R₂NMgX; X = halide) and amido-Grignard (R₂NMgR) complexes†

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The preparation of silylamide Hauser base (R₂NMgX; X = halide) and amido-Grignard (R₂NMgR) complexes from simple Grignard reagents using [K{N(SiMe₂Bu)₂}]ₙ, [K{N(SiMe₂Bu)[Si(Pr)₃]}], and [K{N(SiPr₂)]}ₙ, and their parent silylamines, was explored. Both salt metathesis and protonolysis routes proved ineffective with allylmagnesium chloride as a starting material due to complex Schlenk equilibria, with [Mg(N(R)₃)];{μ₃-Cl}(THF)₂ (N(R)₃ = {N(SiMe₂Bu)₂})₁, (N(SiBuMe₂)[Si(Pr)₃])², and [Mg{N(SiPr₂)₃}{μ₃-H}];(THF)₂ (N(R)₃ = {N(SiMe₂Bu)₂}) identified as minor products. In contrast, salt metathesis protocols using potassium silylamides and methylmagnesium iodide gave [Mg(N(R)₃)];{μ₃-CH₃}(THF)₂ (N(R)₃ = {N(SiBuMe₂)₂})₇a; {N(SiBuMe₂)[Si(Pr)₃]}₈, (N(SiPr₂)₃)₉ and [Mg{N(SiBuMe₂)₃}{μ₃-I}(THF)₂] (10) isolated as a side-product during the preparation of 7a. Unusually, methylmagnesium iodide, di-n-butylmagnesium and 7–9 did not react with HN(R)₃ under the conditions we employed. The synthesis of [Na{N(SiBuMe₂)₃};(THF)₂] (5a) and [Na{N(SiBuMe₂)₃}(DME)] (5b) from benzyl sodium and HN(SiBuMe₂)₂, and a solvent-free structure of [K{N(SiBuMe₂)₃}] (6), are also reported. Complexes 1, 5b, 7a, 7b, 8, 9 and 10 are fully characterised by single crystal XRD, multinuclear NMR and IR spectroscopy and elemental analysis, whereas complexes 2–4, 5a and 6 were identified by XRD only.

Introduction

Grignard reagents are widely utilised due to their facile preparation and broad applicability in organic synthesis,¹,³ yet in stark contrast the synthetic potential of Hauser bases, amido analogues with a N–Mg bond instead of a C–Mg bond, is only starting to be realised.³ This is remarkable as N-donor groups are harder than C-donors and a wider variety of synthetic routes are available to access homo- and heteroleptic N-donor alkaline earth (Ae) complexes⁴ than Ae organometallics.¹,⁴,⁵ Furthermore, highly reactive heteroleptic magnesium complexes with N-donors, such as alkyls and hydrides, are desirable and useful reagents, as they can undergo σ-bond metathesis or protonolysis with a number of substrates, thereby providing access to various synthetic hetero-functionalisations.³,⁶

Sterically demanding N-donor ligands are commonly employed in Ae solution chemistry as they impede oligomerisation, complex Schlenk equilibria and other unwanted degradation pathways in ethereal solvents, particularly for the heavier Ae metals.¹,⁵ Bochmann and co-workers have shown that cationic magnesium complexes with bulky amido ligands such as [Mg(N″){Er₂O₆}][BaF⁴] (N″ = {N(SiMe₃)₂})², BaF⁴ = {B(C₆F₅)₃}², can act as potent ring opening polymerisation catalysts,³ an industrially significant process in which Chisholm and others have shown magnesium catalysts have great promise.⁵ In seminal work by Jones, bulky N-donor ligands have been used to stabilise the first examples of structurally characterised Mg(i) complexes,³ which have since proven their utility as selective one-electron reducing agents in a number of diverse transformations.¹⁰

Multidentate ligands such as guanidinates⁹,¹¹ amido-³,¹⁴ and β-diketimines⁶,⁹,¹¹,¹₃,¹₄ dominate N-donor magnesium chemistry and there are relatively few examples of monodentate complexes.¹₀,⁹,¹₁ In 1994 Power disclosed the first crystallographically authenticated Hauser base complex (R₂NMe₂X; X = halide)¹⁶ [Mg(N′′){μ₃-Cl}{Er₂O₆}]¹⁷ which was originally prepared in 1972 by Wannagat et al. via a proto-

School of Chemistry, The University of Manchester, Oxford Road, Manchester, M13 9PL, UK. E-mail: david.mills@manchester.ac.uk† Electronic supplementary information (ESI) available. CCDC 1408436–1408447 for 1–3, 5a–b, 6, 7a–b, 8–10 and 4. For ESI and crystallographic data in CIF or other electronic format see DOI: 10.1039/c5dt02535d
nalysis reaction between HN" and propylmagnesium chloride in diethyl ether. To the best of our knowledge, the heavier congener [Mg(NN)μ-Br(Et2O)]19 together with the multi-dentate N-heterocyclic carbene (NHC) supported complexes, [(Mg(NN)][MgCl)][μ-NHC]18] and [(Mg(NN)][μ-NHC]18]) (NH3 = [N(CH3CH2CH(NHCHN=Mes)]2, Mes = 2,4,6-trimethylphenyl), are the only other structurally characterised Hauser bases supported by silylated amides. Furthermore, expanding the search to halide Hauser bases of any monoden-tate amide yields only a handful more examples.20,21

Amido-Grignard complexes, (R2NMgR), are better represented in the literature, but again there are few examples that contain silylamides.25 Recently, Mulvey reported the dimeric complex, [Mg(μ-N')(′Bu)2] and the NHC adduct, [Mg(NN)′(′Bu)](′Ipr)] (′Ipr = 1,3-bis-(2,6-diisopropylphenyl)imidazol-2-ylidine), however, in general heteroleptic magnesium silyl-amide complexes remain relatively rare. Amido-Grignard complexes are key intermediates in the formation of monoaalkyl-bis(amido) group 1/group 2 bimetallic systems, which are typically formed directly from secondary amines in the presence of alkali metal and organomagnesium reagents.26 Mulvey and co-workers have widely used such mixed metatation reactions with Hauser bases to prepare bimetallic systems with various degrees of complexity, ranging from simple heterobimetallic compounds to more elaborate architectures, e.g. inverse crown ethers.26 Such systems have been employed in synergic deprotonative metalation chemistry, providing a powerful tool for a number of transformations, and this pioneering work has recently been reviewed by Knochel and co-workers.27 It follows that facile synthetic routes to a wider range of silyl-amide Hauser bases need to be developed in order to enable their future exploitation.

Recently, we have reported a series of bulky silylamines and we have utilised these starting materials to synthesise homo- and heteroleptic alkali metal28 and f-block28,29 complexes. These silylamines include the potassium salts, [(K[N(SiMe2Bu)]2)](C7H8)]∞, [K[N(SiPr′3)3(SiMe2Bu)]]∞ and [K[N(SiPr′3)3]]∞ (Fig. 1), which were used as starting materials herein. Jones and co-workers have also developed synthetic routes to bulky silylamine s-block complexes that are useful ligand transfer agents.30 In this paper, we report the reactions of bulky alkali metal silylamides and parent silylamines with commercially available Grignard reagents to afford a novel series of Hauser base and amido-Grignard complexes.

Fig. 1 The potassium silylamine complexes [(K[N(SiMe2Bu)]2)](C7H8)]∞, [K[N(SiPr′3)3(SiMe2Bu)]]∞ and [K[N(SiPr′3)3]]∞.28

Results and discussion
Reactions of allylmagnesium chloride with silylamines and potassium silylamides

We found that the reactions of both potassium silylamides, [K[RR]], and their parent silylamines with allylmagnesium chloride reproducibly gave mixtures of products and poor yields. Given that propylmagnesium chloride reacts with HN" in diethyl ether to give [Mg(NN)][μ-Cl(Et2O)],17,18 we added allylmagnesium chloride to THF solutions of HN(Si′BuMe2)2, HN(Si′BuMe2)3(Si′Pr3) and HN(Si′Pr3)2 (Scheme 1). Work-up of the respective reaction mixtures after 8 hours reproducibly gave crystals of the chloride Hauser bases, [Mg(NN)][μ-Cl](THF)]2 (NRR′ = (Si′BuMe2)2, 1; (Si′BuMe2)3(Si′Pr3), 2; (Si′Pr3)2, 3), which were minor components of intractable mixtures of products. Complexes 1–3 were structurally characterised (see below) but they could not be separated from the bulk material, which was shown to be a mixture of products by 1H NMR spectroscopy. By increasing the reaction time to 10 days, we were able to improve the crystalline yield of complex 1 to 19%. Improved yields of 2–3 were not achieved by this method so further analysis of these complexes could not be obtained. On the other hand, the attempted salt metathesis reactions between allylmagnesium chloride and the corresponding potassium amides, [K[RR]], did not give the expected amido-Grignard reagents, [Mg(NN)][(C,H3)], despite several attempts at optimising the reaction conditions. However, in the attempted preparation of [Mg[N(Si′Pr3)2]-[(C,H3)]]∞, several crystals of complex 3 were identified together with a crystal of [Mg[N(Si′Pr3)2][μ-C3H5]]∞ (4) by single crystal XRD (see below). These observations suggested that complex Schlenk equilibria processes are taking place in these reaction mixtures.1,31

The 1H and 13C{1H} NMR spectra of 1 in d6-benzene are unremarkable and not shifted considerably from those reported for [K[N(SiMe2Bu)]2]2, although the 29Si{1H} NMR spectrum of 1 exhibits a single resonance (δ: −0.40 ppm) that is shielded in comparison to the related potassium complex (δ: −15.72 ppm).29c Microanalysis was performed multiple times on discrete crystalline samples of complex 1 and consistently low C values were obtained despite good agreement between measured and expected H and N content. This phenomenon was also encountered for complexes 5b, 7b and 9 (see below), even though the 1H, 13C{1H} and 29Si{1H} NMR spectra of these complexes exhibit only minor impurity signals

Scheme 1 Synthesis of complexes 1–3. 
The identities of 1–4 were determined by single crystal XRD experiments (the molecular structure of 1 is depicted in Fig. 2; see ESI Fig. S10–S12† for the structures of 2–4). Selected bond lengths and angles are compiled in Table 1. The dataset obtained for 4 is of poor quality as the crystals were weakly diffracting. Therefore no discussion of the geometric parameters of 4 is given here, but as the connectivity is clear-cut the structure is included for completeness. The magnesium centres in 4 are 3-coordinate, which is rare for magnesium amide structures and even more so for monodentate Mg1 complexes that are each bound by THF. The Mg–O distances (the molecular structure of 1) are 2.405(1) Å; Mg–Cl 2.418(2) Å and Mg–O [2.018(4) Å] distances are longer than those in [Mg(N′)(μ-Cl)]2[Cl–Mg 92.15(6)°; Cl–Mg–Cl 87.85(6)°] and two 4-coordinate magnesium centres that are each bound by THF. The Mg–Cl [2.418(2) and 2.411(2) Å] and Mg–O [2.018(4) Å] distances are within the range of those for Na–Na bond. As with potassium salt [Na{N(SiMe2Bu)2}(THF)]2 as a dark oil following work-up (Scheme 2). Attempted crystallisation from pentane gave only several crystals of [Na–N(SiMe2Bu)2](THF)]2 (5a); therefore the residue was treated with DME and recrystallised from pentane to afford [Na{N(SiMe2Bu)2}(DME)]2 (5b) as a beige solid in fair yield (65%). The NMR spectra of 5b exhibit similar features to the potassium salt [K{N(SiMe2Bu)2}]2, although 5b contains two additional resonances for coordinated DME in both the 1H (δ = 2.80 and 2.88 ppm) and 13C (δ = 59.21 and 71.30 ppm) NMR spectra. 29Si(1H) NMR spectroscopy shows a single resonance for 5b (δ = −13.89 ppm; cf. [K{N(SiMe2Bu)2}]2, δ = −15.73 ppm). 29a

The solid state structures of 5a and 5b are depicted in Fig. 3 and 4 respectively, and selected bond lengths and angles are shown in Table 1. Both complexes exhibit bond metrics typical of silylamide group 1 salts. 26,33 Complex 5a is dimeric, with a central Na2N2 solvent-capped core and a mean Na–N distance of 2.4903(6) Å, which is longer than the mean Na–N bond length in [Na–N(SiMe2Bu)2](THF)]2 [2.399(2) Å]35a [Na–N(SiMe2Bu)2](μ-TMEDA)2 (TMEDA = N,N,N′,N′-tetramethylethlenediamine) [2.4433(10) Å]35b and [Na–N(SiMe2Bu)2](THF)]2 [2.440(4) Å].35c This can be attributed to the increased steric demands of the silylamide ligands in 5a. The sodium coordination spheres in 5a are completed by multiple short Na–C–H/Na–H distances [Na–C range 2.827 (4)–3.028(4) Å; Na–H range 2.48–2.88 Å], in common with the potassium salt [K{N(SiMe2Bu)2}(THF)]2 (C–H distances), which exhibits analogous K–C–H/K–H contacts. 28 Complex 5b is monomeric in the solid state, with a 5-coordinate sodium centre and exhibits shorter Na–N distances [2.350(3) Å] than those in 5a, as would be expected for a terminally bound silylamide. The Na–O distances of 5b [range 2.425(3)–2.567(4) Å] are within the range of those for Na–DME interactions in the literature [2.402(9)–2.658(7) Å].16c To the best of our knowledge, [Sm[[N(η-C(CH3)3)]2CHC(N′Pr)Na(DME)]2κ3–N,N′,N′](N(SiMe2Bu)2) (Ar = C6H4·H(Pr)2·2H2O) is the only other literature example containing a terminal, DME-capped N–Na bond. As with 5a, the coordination sphere of sodium in 5b is also completed by short Na–C–H contacts [range Na–H 2.84–3.06 Å]. The reaction of 5b with allylmagnesium chloride in THF was performed in an attempt to synthesise [Mg{N(SiMe2Bu)2}]2.
Selected bond lengths (Å) and angles (°) for 1–3 and 5–10

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<th>Bond Lengths (Å)</th>
<th>Bond Angles (°)</th>
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<td>2.411(2)</td>
<td>Mg(1)–O(1) 2.014(4)</td>
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<td>Cl(1)–Mg(1)–Cl(1A) 87.85(6)</td>
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<td>Mg(1)–Cl(1)–Mg(1A)</td>
<td>92.15(6)</td>
<td>N(1)–Mg(1)–O(1) 118.33(16)</td>
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<td>N(1)–Mg(1)–Cl(1)</td>
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<td>Si(1)–N(1)–Si(2)</td>
<td>126.8(2)</td>
<td>Si(1)–N(1)–Si(2) 135.93(15)</td>
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Reactions of methylmagnesium iodide with silylamines and potassium silylamides

Methylmagnesium iodide reacts with potassium silylamides, [K(NRR)]+, to give amido-Grignard complexes in fair yields, but protonolysis reactions with the parent silylamines were unsuccessful. As the reaction of [K(N(Si(tBuMe2))(SiiPr3))] with allylmagnesium chloride is slow and gives poor yields of 1 (see above), we selected methylmagnesium iodide as an alternative starting material, which has been extensively used in the literature as a reagent for the preparation of L–Mg–X and L–Mg–R complexes. In the course of synthesising potassium silylamide precursors for this study, crystals of [[K(μ-N-Si(BuMe2))(SiiPr3)]2(C2H5)]2 were obtained and identified by single crystal XRD. The amido-Grignard complexes [Mg(NRR)]=μ-(CH3)2]2 (7a), [N(Si(tBuMe2))(Si(Pr3))]2, 7a; [N(Si(tBuMe2))(Si(Pr3))]2, 8; [N(Si(Pr3))]2, 9) were obtained by salt-metathesis reactions using the appropriate potassium amides and methylmagnesium iodide in diethyl ether, and treatment of 7a with DME gave [Mg(N(Si(tBuMe2))(CH3))(DME)] (7b) (Scheme 3). Workup and crystallisation from...
hot toluene afforded colourless crystals in poor (7a and 7b), fair (9) and excellent (8) yields, respectively. On one occasion a small crop of the Hauser base \([\text{Mg}\{\text{N(Si}^t\text{BuMe}_2)\}_2]\{\mu\text{-I}\}[\text{THF}]_2\) (10) was obtained (4%) when attempting to isolate 7a, which has presumably formed \textit{via} complex Schlenk equilibria.\textsuperscript{1} Treatment of methylmagnesium iodide with HNRR’ in diethyl ether gave no reaction even after extended reaction times (>3 days at room temperature) or heating the reaction mixture under reflux for three hours. Furthermore, we found that 7a does not react with HN(Si^tBuMe_2)_2 under similar forcing conditions in hexanes. Germane to this, no reaction was observed between di-n-butyll magnesium and HN(Si^tBuMe_2)_2 in a mixture of heptane and hexanes. Refluxing this reaction mixture for extended periods gave an intractable mixture of products. Together, these experiments illustrate the sluggishness of protolysis reactions between alkylmagnesium complexes and HNRR’. Complexes 7–10 were characterised by single crystal XRD studies (see below), elemental analysis and NMR and IR spectroscopies. To the best of our knowledge, 7a, 8 and 9 are the first examples of structurally characterised dimeric...
CH$_3$-bridged Hauser bases with monodentate N-donor ligands. Complex 7b is unusual as it is monomeric with a terminal Mg–CH$_3$ group, and there are few examples of this motif in the literature.

The $^1$H and $^{13}$C($^1$H) NMR spectra of 7–10 contain unremarkable silylamide ligand resonances, but the shielded methyl resonances in 7–9 $\delta$: 0.71 ppm (7a); 0.99 ppm (7b); 0.81 ppm (8); 0.80 ppm (9); 0.80 ppm (7a); 0.80 ppm (8), 0.67 ppm (9) are in agreement with those of structurally characterised examples in the literature ($\delta_N$ range 2.00 ppm to 0.67 ppm). The similarity of the methyl group chemical shifts in 7–9 with monodentate N-donor complexes in the literature suggests that the spectator ligand does not greatly influence these values.

One resonance is observed in the $^{29}$Si($^1$H) NMR spectra of 7a, 7b, 9 and 10 and two resonances were found for 8 $\delta$: −1.93 ppm (7a); −2.43 ppm (7b); −2.90 and −1.76 ppm (8); −3.15 ppm (9); −1.19 ppm (10), correlating with the number of unique silicon environments.

The identities of 7a, 7b, 8, 9 and 10 were determined by single crystal XRD and are depicted herein (7a: Fig. 6; 7b: Fig. 7; 9: Fig. 8; see ESI Fig. S13 and S14† for the structures of 8 and 9), with selected bond lengths and angles compiled in Table 1. The structures of 7a, 8 and 9 are broadly similar, with 3-coordinate Mg centres and bridging CH$_3$ moieties to form central Mg$_2$C$_2$ rhomboids with centres of inversion. The Mg–N distances [7a]: 1.956(3) Å, 1.9658(18) Å; 9: 1.977(2) Å] are slightly shorter than in 1, 2 and 3 respectively, which is a reflection of the absence of coordinated solvent molecules in 7–9. The mean Mg–C bond lengths in 7a, 8 and 9 are comparable [7a]: 2.217(6) Å; 8: 2.236(3) Å; 9: 2.232(5) Å and are typical of methylmagnesium amides [previously reported range Mg–C 1.977(3)–2.434(13) Å]. The MgNSi$_2$ fragments of all three ligands are roughly planar in 7a, 8 and 9; these planes are twisted relative to the central Mg$_2$C$_2$ plane by differing amounts [7a: 74.38(11)°; 8: 63.95(8)°; 9: 67.77(10)°] with no clear trend. In the dimeric unit, the two ligand Si–N–Si fragments are also co-planar with each other to within 0.1° for all three structures. The coordination spheres of the magnesium centres in 7a, 8 and 9 are completed by a number of short Mg⋯C–H/Mg⋯H distances. Complex 7b is monomeric due to the coordinated DME molecule and the Mg–N [2.0293(15) Å] and Mg–C [2.118(2) Å] bonds are correspondingly shorter than those in 7a. However, the coordination sphere of the magnesium centre is again completed by short Mg⋯C–H/Mg⋯H distances. Complex 10 exhibits a near-square Mg$_2$I$_2$ central motif, with the sum of the four internal angles calculated at 359.99(12)°. The two Mg–I bond lengths in 10 [2.8280(18) and 2.8187(19) Å] are similar to those observed for literature examples that contain N–Mg–I moieties and bridging iodide ligands [range 2.7766(12)–2.9013(3) Å]. Finally, in common with 1–3, the coordination sphere of Mg is completed by a THF molecule [Mg–O 2.010(4) Å] and multiple short Mg⋯C–H/Mg⋯H distances.

**Conclusions**

We have structurally characterised a series of silylamide Hauser bases during our exploration of straightforward syn-
thetic routes to these complexes. Protonolysis routes to Hauser base complexes by treating allylmagnesium chloride, di-\(n\)-butylmagnesium or methylmagnesium iodide with a series of silylamines were found to be slow and prone to complex Schlenk equilibria. A fully characterised isolated product, \(1\), was achieved on only one occasion by using extended reaction times. The salt metathesis reactions of allylmagnesium chloride with potassium silylamides, and the novel sodium silylamine, \(5b\), gave intractable mixtures. We concluded from these studies that, using these ligand systems and methodologies, allylmagnesium chloride is unsuitable as a starting material for reproducible syntheses of silylamine Hauser base and amido-Grignard complexes.

Salt metathesis reactions of potassium silylamides with methylmagnesium iodide were found to be a far more successful strategy, giving modest to excellent yields of the amido-Grignard complexes 7–9. The isolation of a small amount of the iodide Hauser base complex \(10\) indicated that complex Schlenk equilibria also operate in these reaction mixtures, slightly reducing the yields of the target complexes. Despite these side-reactions, facile synthetic routes to amido-Grignard complexes of three different silylamide ligands have been achieved. We envisage that such amido-Grignard ligands could be useful reagents for heterofunctionalisation reactions. Additionally, such compounds could pave the way for the preparation of novel bimetallic systems with alkali metals, which could potentially be employed in synergic metalation reactions.

**Experimental**

**Materials and methods**

All manipulations were carried out using standard Schlenk and glove box techniques under an atmosphere of dry argon. Solvents were dried by refluxing over potassium and degassed before use. All solvents were stored over potassium mirrors (with the exception of THF and DME which were stored over activated 4 Å molecular sieves). Deuterated solvents were distilled from potassium, degassed by three freeze–pump–thaw cycles and stored under argon. [K\(\{\text{N(Si}^\text{t}BuMe}_2\}_2\}]_n^{29a} [K\{\text{N-} (\text{Si}^\text{t}BuMe}_2)(\text{Si}^\text{Pr}_3)_2\}]_n^{28} [K\{\text{N(Si}^\text{Pr}_3)_2\}]_n^{29b} were prepared according to published procedures. [Na(CH\(_2\)C\(_6\)H\(_5\))] was prepared via a modification of published procedures.\(^{34}\) All other chemicals were used as purchased and stored appropriately.

Most solid reagents were dried under vacuum for four hours and most liquid reagents were dried over 4 Å molecular sieves and distilled before use. \(^1\)H, \(^13\)C\((^1\)H\) and \(^29\)Si\((^1\)H\) NMR spectra were recorded on a spectrometer operating at 400.2, 100.6 and 79.5 MHz, respectively; chemical shifts are quoted in ppm and are relative to TMS. FTIR spectra were recorded as Nujol mulls in KBr discs on a Perkin Elmer Spectrum RX1 spectrometer. Elemental microanalyses were carried out by Mr Stephen Boyer at the Microanalysis Service, London Metropolitan University, UK.

**Synthetic procedures**

\[\text{[Mg[N(Si}^\text{t}BuMe}_2)_2]\{\mu-\text{Cl}(\text{THF})\}_2\] (1). Allylmagnesium chloride (1.5 mL, 2.0 M in THF, 3 mmol) was added dropwise to a precooled solution \(-78 \, ^\circ\text{C}\) of HN\(\{\text{Si}^\text{t}BuMe}_2\}_2\) (0.74 g, 3 mmol) in THF (20 mL). The reaction mixture was allowed to warm to room temperature, forming a white precipitate which redissolved to give a colourless solution. After 10 days stirring at room temperature volatiles were removed \textit{in vacuo} to leave a
white solid which was washed with hexanes (4 mL). The solid residue was dried in vacuo and extracted with hot toluene (15 mL). Storage of the toluene solution at −20 °C for 24 hours gave 1 as colourless crystals (0.44 g, 19%). Anal. Caled for C17H43MgNO2Si2·0.1C7H8: C , 55.47; H, 12.89 (%). Dimethoxy-silicon-rich molecule, as has been observed previously.29a,32 1H NMR (δC benzene, 298 K): δ = 0.38 (s, 24H, Si(CH3)2), 1.18 (s, 36H, Si(CH3)2), 1.24 (m, 8H, THF–CH2), 3.84 (m, 8H, THF–OCH2). 13C(1H) NMR (δC benzene, 298 K): δ = 2.72 (Si(CH3)2), 20.98 (Si(CH3)2), 25.16 (THF–CH2), 29.32 (Si(CH3)2), 71.19 (THF–OCH2). 29Si(1H) NMR (δC benzene, 298 K): δ = −0.40 (Si′BuMe2), FTIR (Nujol, cm−1): ν = 1259 (s), 1246 (s), 1019 (s), 983 (s), 844 (m), 829 (s), 795 (s), 722 (m), 660 (m).

[Na[μ-N(Si′BuMe2)3][μ-Cl](THF)]2 (5a) and [Na[N(Si′BuMe2)3][μ-C3H8]2](DME)2 (5b). HN[Si′BuMe2]3 (2.65 g, 10.8 mmol) in THF (10 mL) was added dropwise to a pre-cooled −78 °C solution of [KH(N(Si′BuMe2)3)2] (1.10 g, 3 mmol) in THF (15 mL) at. The reaction mixture was allowed to warm to room temperature and stirred for 12 hours to form a dark orange solution. Removal of volatiles in vacuo gave a white solid which was extracted with hot toluene (2 mL). Storage at −20 °C for 24 hours afforded 2 as colourless crystals in an intractable mixture of products.

[Na[μ-N(Si′BuMe2)3][μ-Cl](THF)]2 (5a) and [Na[N(Si′BuMe2)3][μ-C3H8]2](DME)2 (5b). HN[Si′BuMe2]3 (2.65 g, 10.8 mmol) in THF (10 mL) was added dropwise to a pre-cooled −78 °C solution of [KH(N(Si′BuMe2)3)2] (1.10 g, 3 mmol) in THF (15 mL). The reaction mixture was allowed to warm to room temperature and stirred for 12 hours to form a dark orange solution. Volatiles were removed in vacuo to give a brown dark oil which was dissolved in pentane (5 mL). Storage at −20 °C afforded several colourless crystals of 5a. Volatiles were removed in vacuo and the resultant oil was dissolved in dimethoxyethane (5 mL) and stirred for 8 hours. Volatiles were removed in vacuo and the oil was dissolved in pentane (5 mL) and stored at −20 °C to afford colourless crystals of 5b. These were washed with cold pentane (5 mL) and dried in vacuo to give a beige powder (3.15 g, 65%). Anal. Caled for C53H106Na2O4Si3: C, 53.68; H, 11.26; N, 3.13. Found C, 48.64; H, 11.02; N, 3.41 (%). 1H NMR (δC benzene, 298 K): δ = 0.30 (s, 12H, Si(CH3)2), 1.28 (s, 18H, Si(CH3)2), 2.80 (s, 8H, DME–OCH2), 2.88 (s, 12H, DME–OCH2), 13C(1H) NMR (δC benzene, 298 K): δ = 2.17 (Si(CH3)2), 20.79 (Si(CH3)2), 28.72 (Si(CH3)2), 59.21 (DME–OCH2), 71.30 (DME–OCH2). 29Si(1H) NMR (δC benzene, 298 K): δ = −13.89 (Si′BuMe2). FTIR (Nujol, cm−1): ν = 1117 (s), 1086 (s), 1030 (s), 819 (s), 802 (s), 637 (m).

[K[N(Si′BuMe2)3]]2 (6). Crystallisation of a small portion (1.00 g, 3.5 mmol) of the previously reported compound [(K[μ-N(Si′BuMe2)3][μ-C3H8])2(CH2)n]28,29a from hexane gave 6 as large colourless blocks.

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forming a white precipitate. Filtration and removal of volatiles in vacuo yielded a white precipitate. This was dissolved in hot toluene (15 mL) and colourless crystals of \( \text{F} \) formed at room temperature (1.46 g, 93%). Anal. Calcld. For \( \text{C}_{12}\text{H}_{12}\text{Si} \), 1.12 (m, \( 6\text{H}, \text{SiCH}_2\text{CH}_3 \)), 1.15 (s, \( 18\text{H}, \text{SiC} \text{H}_3\text{H} \)), 0.10 (s, \( 6\text{H}, \text{Mg-CH}_3 \)), 1.15 (s, \( 18\text{H}, \text{SiC} \text{H}_3\text{H} \)), 0.10 (s, \( 6\text{H}, \text{Mg-CH}_3 \)), 1.15 (s, \( 18\text{H}, \text{SiC} \text{H}_3\text{H} \)), 0.10 (s, \( 6\text{H}, \text{Mg-CH}_3 \)), 1.15 (s, \( 18\text{H}, \text{SiC} \text{H}_3\text{H} \)), 0.10 (s, \( 6\text{H}, \text{Mg-CH}_3 \)), 1.15 (s, \( 18\text{H}, \text{SiC} \text{H}_3\text{H} \)), 0.10 (s, \( 6\text{H}, \text{Mg-CH}_3 \)), 1.15 (s, \( 18\text{H}, \text{SiC} \text{H}_3\text{H} \)), 0.10 (s, \( 6\text{H}, \text{Mg-CH}_3 \)), 1.15 (s, \( 18\text{H}, \text{SiC} \text{H}_3\text{H} \)), 0.10 (s, \( 6\text{H}, \text{Mg-CH}_3 \)), 1.15 (s, \( 18\text{H}, \text{SiC} \text{H}_3\text{H} \)), 0.10 (s, \( 6\text{H}, \text{Mg-CH}_3 \)).

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**References**


