Interstellar Molecules – A Guide for New Chemistry

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The interstellar space is one of the most remarkable chemical laboratories in the universe. The existence of a number of species with low valent elements has been characterized by scientists from astrophysics. Therefore it is a challenge for a chemist to prepare compounds with low valent elements in the laboratory and study their chemistry. Moreover to stabilize these species to be stable at room temperature for further reactions.

We were able to prepare and study the chemistry of aluminum(I), silicon(I), silicon(II), germanium(I), germanium(II), and tin(II) compounds. The low valent state can be arrested by using sterically bulky ligands or base stabilizing procedures.

Methods for the preparation of compounds with the following composition NHC·$SiCl_2$ (NHC = N-heterocyclic carbene), LSi(II)H (L = monovalent amidinate), LSi(II)F, LSi(I)-Si(I)L will be given, and their reactions with phosphorus, ketones, alkines, partly- and per-fluorinated aromatics, 2,3-dimethylbutadiene, azobenzene, and diazo compounds are reported. In the case of germanium and tin the monohydrides of composition LM(II)H (L = ß-diketiminate, M = Ge, Sn) have been prepared. Due to the larger radius of the M(II) in comparison with the M(IV) cations, the compounds show an increased reactivity. For example LGeH and LSnH react below room temperature with CO_2 under insertion into the metal-hydrogen bond. Comparable reactions with M(IV) species need an additional transition metal catalyst.

Furthermore, perfluorinated aromatics can be converted selectively to the monohydrides using Group 14 hydrides with low valent elements.

The X-ray structures and bonding properties of these new species will be discussed.