

Preface

“Damit aber wird alle Grundlagenforschung zur Zweckforschung auf weite Sicht” [1]. This important statement given in a lecture on *Intermetallic Compounds* at a conference of the German Chemical Society in 1932 indicated the visionary power of the German chemist Eduard Zintl (1898–1941), since the subclass of intermetallic compounds, which he had discovered, and which have been named “Zintl phases” by *Laves* in 1941 [2], advanced to one of most inventory subjects in materials science during the last century.

During the ensuing period, Zintl’s original understanding of these polar intermetallic compounds as salt-like species, in which the valence electrons are formally transferred from the more electropositive to the more electronegative component, has relocated the unadulterated description of intermetallic compounds in terms of geometrical aspects such as coordination numbers, coordination polyhedra and atomic radii ratios, and their electronic situations which had been considered as delocalized electronic systems by means of free-electron gas models and average electron numbers (valence electron concentration). This new approach has led to the idea that metal atoms in Zintl phases form localized covalent and even multiple and multi-center chemical bonds solely based on the valence rules and molecular orbital descriptions as generally accepted in molecular chemistry. At the same time, it has helped to predict their structures and properties and thus has made Zintl phases most valuable candidates for the tuning of specific structures and electronic/magnetic properties. In the case of soluble Zintl phases resulting solutions contain so-called *Zintl anions*. This important field is treated within this series in Volume 140 *Zintl Ions* (edited by *T.F. Fässler*).

In this book, the progress in the field of Zintl phases from Zintl’s original ideas to the application of these compounds in materials science is outlined. In the first chapter, *GJ Miller et al.* report on quantitative advances in the Zintl–Klemm formalism based on first-principle calculations. The next chapter by *J Evers* is dedicated to the behavior of Zintl phases under high pressure and deals with *in situ* experimental studies complemented by theoretical investigations on the basis of DFT calculations. The very rich chemistry of Zintl phases with clathrate-type structures, in which 40% of all stable elements of the Periodic Table are involved,

is presented by *A Shevelkov and K Kovnir* in another chapter. The reader is also directed to the chapter of Santamaría-Pérez and Liebau in Volume 138 of *Structure and Bonding* edited by *A Vegas*, which shows in detail the structural relationship of Zintl-type clathrates, porous tectosilicates, and clathrate hydrates. In the last chapter, *U Häussermann et al.* describe the reactions of Zintl phases with elemental hydrogen which can lead to interstitial hydrides as well as to polyanionic hydrides with hydrogen covalently bound to atoms of the polyanions of a Zintl phase, and thus makes hydrogen-containing Zintl phases important model systems for fundamental studies of hydrogen–metal interactions.



Reopening ceremony of the Eduard Zintl Institute in 2002 at the Technical University of Darmstadt (from left to right: TF Fässler (director), KH Lieser, bust of Eduard Zintl, B Eisenmann, H-F Klein, J Brickmann).

- [1] Zintl E (1939) Intermetallische Verbindungen. *Angew Chem* 52:1 (*Thus, all fundamental research becomes applied research on a long term*)
- [2] Laves F (1941) *Naturwissenschaften* 29:244 (*Eduard Zintls Arbeiten über die Chemie und Struktur von Legierungen*)

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Zintl Phases

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