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Organometallic chemistry: Profile of an interdisciplinary area

A direct chemical bond between carbon and a metal has profound impact on the chemical reactivity of the partners. The numerous ways in which such bonds can possibly form between a metal and carbon atom/atoms in organic molecules to generate different entities, resulted in the evolution of a distinct discipline in chemistry known as *organometallic chemistry*. The chemistry of metal-carbon bond now dominates a wide arena of chemical research – extending from synthetic chemistry to industrial catalysis, cancer therapy, bonding theory and futuristic materials. By its very nature, it thrives on a great deal of collaborative interdisciplinary research. The tremendous growth of the subject is best showcased by the two series (sets of nine and fourteen volumes) of *Comprehensive Organometallic Chemistry*¹ published within a span of less than two decades. The global thrust on 'green technology' and strict insistence on enantiomerically pure, bioactive molecules in medicine and agriculture, directed and defined – to a large extent – this phenomenal growth of basic research in chemistry and catalysis². Research in materials science also draws a great deal from the gigantic repository of novel materials whose physical properties can be fine-tuned by selection of widely available elements and groups and their myriad combinations.

In this special section of *Current Science*, we have brought together a set of seven articles that range from accounts of specific research activity of a group to extensive review of important areas in chemical technology.

The central concern of synthetic organometallic chemistry is making and breaking of metal-carbon bonds. The bond between carbon – the key organic element that sustains life and its diversity, and a metal atom – of transition or non-transition genre – modifies the normal reactivity traits of both partners, and new reactions are frequently discovered. The first five articles address

chemical reactivity and utility of organometallics.

A common and well-studied, hazardous yet inexpensive and commercially available organometallic compound is iron pentacarbonyl. The article by M. Periasamy and coworkers (page 1307) is an account of their extensive exploitation of iron carbonyl chemistry in search of new reactivity patterns by changing reaction parameters and additives. Moving on to catalytic asymmetric synthesis from stoichiometric transformations, Simon Woodward (page 1314) describes an interesting way of correlating physical organic principles like consideration of hard-soft acid-base relationships with efficacy in asymmetric catalysis. Catalysis need not necessarily confine itself to single-site activation on a metal centre, as Sumit Bhaduri (page 1318) discusses in his article on platinum cluster catalysis – catalysis using multi-metal centres – that tends to mimic biological redox processes in aqueous medium.

Catalyst design in Ziegler-Natta polymerization has undergone a sea change in concept and practice. Early transition metal-derived, single-component, designer catalysts of *ansa*-metallocene era face stiff challenges from late transition metal catalysts for polyolefin synthesis in terms of efficiency and convenience, though the commercial viability is yet to be established for either of them. Chandrasekhar and Sivaram (page 1325) review the developments comprehensively. In the following article, Blaser *et al.* (page 1336) provides an overview of realities and concerns of industrial adaptation of homogeneous catalysis in the manufacture of bulk and fine chemicals. The opening paragraphs introduced the concepts and nomenclature in vogue in organometallic chemistry, followed by analysis of representative chemistry and production data. The article concludes with a prognosis for future developments.

Interestingly, organometallic chemistry evolved over the past decades largely by studying diamagnetic compounds, and an overwhelming majority of structural and

conformational studies were conducted with the help of NMR spectroscopy. Pariya and Theopold (page 1345) recounted an unusual, but rich and potentially useful chemistry of paramagnetic organochromium complexes. Innovative NMR methods were developed to study these paramagnetic compounds, extensive use was made of magnetic measurements and crystal structure determination to follow the unusual course of chemical reactions. An exciting finding was the confirmation of Cr(III) complexes as functional models in a homogeneous medium of an industrially used heterogeneous catalyst for polymerization, a theme currently being exploited by the group for eventual practical application.

Synthetic chemists continue to offer solutions to problems in materials science. In the last article, Luh and his associates (page 1352) describe the utility of several key organometallic reactions in developing viable methodology to obtain electroluminescent polymeric materials. Selection and relative placement of chromophoric groups in the polymer backbone are crucial factors in designing such useful materials, and predesigned monomers have been assembled in an amazingly simple way with the desired purity using well-established metal-mediated chemical transformations. The authors maintain that many such innovative exploitations of organometallic reactions in materials science await the intervention of creative synthetic chemists.

1. *Comprehensive Organometallic Chemistry* (eds Wilkinson, G., Stone, F. G. A. and Abel, E. W.), Pergamon, 1982 (series I); 1995 (series II).
2. *Transition Metals for Organic Synthesis: Building Blocks and Fine Chemicals* (eds Beller, M. and Bolm, C.), Wiley-VCH, 1998; *Applied Homogeneous Catalysis with Organometallic Compounds* (eds Boy, C. and Herrmann, W. A.), Wiley-VCH, 1996, vols 1 and 2; *Aqueous Phase Organometallic Catalysis: Concepts and Applications* (eds Boy, C. and Herrmann, W. A.), Wiley-VCH, 1998.

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